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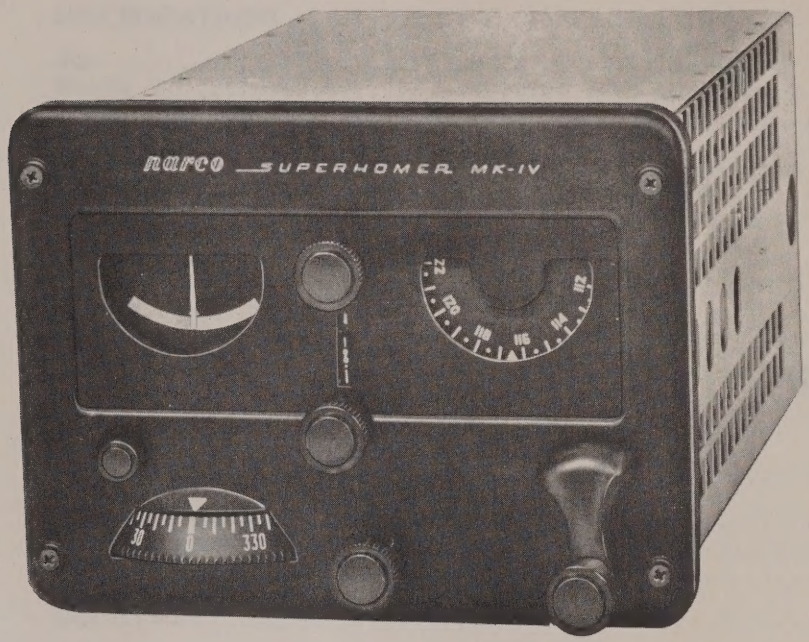

Superhomer MK-IV

Type VHT-4

VHF COMMUNICATION
and
OMNI NAVIGATION EQUIPMENT

MAINTENANCE MANUAL

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

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SECTION 1
GENERAL INFORMATION

1-A. INTRODUCTION

1-A,1. NARCO Mark IV Superhomer.

The Superhomer is basically a Single Unit Airborne VHF Equipment, designed to provide two-way Communication and Omni Navigation with the associated ground facilities of the Airways Radio System. For operation it requires only connection to a nominal 12 volt d.c. source for power, together with the usual connections to antennas, headphones and loudspeaker, and a microphone.

The Receiver, Transmitter and Omni Controls are on the Front Panel of the Unit, which is intended to be mounted in a position convenient for direct operation by the Pilot.

The Receiver has continuous tuning from 108 to 127 megacycles, covering all of the VHF Omni Navigation Frequencies and all of the principal VHF Communication Frequencies. Provision is made for setting the Receiver Tuning accurately to any frequency for which a crystal is provided in the Transmitter.

The Transmitter is normally supplied with either a minimum of 9 crystals for 9 channel operation, or with the maximum of 27 crystals for 27 channel operation. If a 9 channel equipment is originally provided it can be easily fitted for 27 channel operation, by purchasing and plugging in a kit of 18 additional crystals. The crystal kit number for the 18 crystals is NARCO M72017-102.

The Omni Navigation feature operates whenever the Receiver is tuned to a VHF Omni Station within range. A single Instrument serves as either a LEFT-RIGHT Course Indicator or a TO-FROM Signal, by the operation of a switch. A single thumb wheel operates the easily read Course Selector.

The Mark IV Superhomer is Electrically and Mechanically interchangeable with its predecessor the VHT-3 Superhomer.

1-B. SPECIFICATIONS

1-B,1. Size.

a. CASE:
Width—6-11/32″
Height—4-13/16″
Depth—10-17/64″ plus 3″ at rear for plug removal, cables and ground support strap.

b. FRONT PANEL:
Width—6-7/8″
Height—5-1/16″
Depth—1-31/32″ total including all knobs and controls.

1-B,2. Weight.

Unit with Case 7.5 lbs. This does not include external accessories such as antennas, cables, headphones, microphone, etc.

1-B,3. Power Required.

a. Receive 4.0 amps at 13.75 volts.
b. Transmit 5.0 amps at 13.75 volts.

NOTE—There is no provision for operation from a nominal 24 volt d.c. source.

1-B,4. Transmitter.

a. Frequency Range: 118.0 to 123.0 megacycles.
b. Power Output: 1.0 watt minimum at 13.75 volts d.c. input.
c. Modulation: 70% minimum, with limiting to prevent overmodulation.

1-B,5. Receiver.

a. Frequency Range: 108.0 to 127.0 megacycles.
b. Sensitivity: 6 db $\frac{S + N}{N}$ with an input signal of 1.5 microvolts maximum. (S = Signal, N = noise)
c. Audio Output: 2.5 watts minimum, at a maximum of 20% distortion, with a 10 microvolt input signal.

1-B,6. Omni Accuracy: Nominal ±5 degrees.

SECTION 2
INSTALLATION

2-A. EQUIPMENT

2-A,1. Equipment Supplied.

a. Narco Mark IV Superhomer, 9 Transmitter channels, with Case.

or

b. Narco Mark IV Superhomer, 27 Transmitter Channels, with Case.

c. Cable Assembly, Audio, Narco No. 90564-36.

d. Fuse Holder, Narco No. 41148-103, with 10 amp fuse.

e. Brackets, for Case Mounting, two, Narco No. 84019-1.

2-A,2. Equipment Required but Not Supplied.

a. Communication/Navigation Antenna, with Balun", Cable and Connector.

b. Transmitting Antenna with Cable and Connector.

c. Headphones, Loudspeaker, or both if desired.

d. Microphone.

2-A,3. Optional Equipment Available.

a. Antenna for Communication and Navigation reception, Narco VRP-15A, Pedestal type, or Narco VRP-37 Tail Fin mounting type. Both are supplied with the required "Balun", Cable and Connector.

b. Antenna for Communication Transmission. Narco VTP-17, Bent Rod type. It is supplied with a Cable and Conector.

2-B. LOCATION

2-B,1. Mark IV Superhomer.

The Unit is intended to be mounted in a position convenient for direct operation by the pilot. It may be mounted directly in a cutout in the Instrument Panel, or wherever a suitable space is available. The Unit fits into a case which is usually installed permanently. When the case is properly installed, the unit can be easily removed for service and maintenance. All necessary information for mechanical installation is given in the illustration, Figure 5, page 25. No external Power Unit is required.

2-B,2. Support and Ground.

An 8-32 thread Machine Screw Stud is provided near the top center, at the rear of the Case. It should be used for a rear support strap and a chassis ground connection.

2-C. POWER REQUIRED

2-C,1. Primary Voltage and Currents.

a. Receive 4.0 amps at 13.75 volts.

b. Transmit 5.0 amps at 13.75 volts.

NOTE—There is no provision for operation from a nominal 24 volt d.c. source.

2-C,2. Power Connection.

The lead which extends from the rear of the set and includes a fuse holder should be connected to a point in the airplane's electrical system which can provide 13.75 volts at 10 amperes. The normal drain at this voltage is 4.0 amps. Receive and 5.0 amps. Transmit. Battery voltages higher than 16.0 can damage the Vibrator and other Components.

2-D. AUDIO AND CONTROL CIRCUITS

2-D,1. Phones, Speaker, Microphone.

The Audio Cable Assembly supplied with the Equipment, Narco No. 90564-36 has on one end a connector which mates with the Connector X-401 (shown on the Schematic Figure 15, page 41) at the rear of the Unit. The other end of the Cable is wired to two jacks and has an unterminated lead intended for loudspeaker connection. The two jacks are the common single circuit and double circuit jacks, to take headphone and microphone plugs respectively. They are usually mounted at a convenient place on or near the instrument panel.

2-D,2. Audio and Control Connections.

Terminal No.	Wire Color	Circuit or Function
1	BLACK	Ground (Common to Mic., Phones and Speaker.)
2	BROWN	Microphone Jack Ring, Voice Circuit.
3	WHITE	Microphone Jack Tip, Transmit Key.
4	GREEN	For Speaker Connection.
5	BLUE	Headphone Jack Tip, Receiver Audio Output.
6	—	No Connection.

2-D,3. Headphone and Speaker Circuits.

The Headphone circuit output impedance is about 300 ohms and is intended for one or two pairs of headphones having 600 ohms impedance. The speaker circuit output impedance is about 3 ohms and is suitable for speakers having impedances of 3 to 6 ohms.

2-D,4. Microphone.

The microphone circuit is intended for a high level carbon type, preferably of the noise-cancelling variety. The microphone assembly should have a switch or push button circuit to control the transmitter (PUSH-to-TALK).

2-E. ANTENNAS

2-E,1. Communication/Navigation Receiving Antenna

The full range and accuracy of the VHF omni-range system can be realized only when the airplane is equipped with the proper type of antenna. **For omni-range reception, a horizontal V-type antenna is absolutely necessary; a vertical whip is definitely not satisfactory,** although it may appear to be when tried. Vertically polarized components are not radiated by the ground stations, but are produced by reflections from trees and similar objects. Therefore a vertical antenna may receive strong signals, but they are reflections and do not come directly from the ground station, giving rise to very unreliable bearings.

The type VRP-15A horizontal V antenna when used should be carefully installed preferably on top of the airplane behind the cockpit, and well away from the engine and propeller. An alternate type of antenna, type VRP-37, is available for mounting on the upper part of the vertical stabilizer. The nose of the V should face directly forward or aft, and the rods should be horizontal in level flight attitude

The mast of the type VRP-15A antenna contains a matching balun which serves as an impedance transformer and as a means to connect a coaxial line to the balanced V antenna. The type VRP-37 antenna is supplied with an external balun which attaches to the antenna rods. The other end of the balun is factory connected to the coaxial line which connects to the set.

Either balun is made of a special 35 ohm coaxial transmission cable cut to critical dimensions which should not be altered. The sheath of the coaxial line to the set should be connected to the sheaths of both balun cables and grounded directly to the skin of the aircraft. The VRP-15A mast includes this connection in its base. The VRP-37 cable assembly is provided with a grounding lug for making this connection.

A "T" connector kit, type VRP-39, is available for dual receiver installation. A small loss in receiver sensitivity may be experienced, when two receivers are operated from the same antenna.

2-E,2. Transmitting Antenna.

The vertical whip type transmitting antenna should be mounted on a metal plate measuring at least 18 inches square for best results. Such a mounting surface is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface is available, a piece of thin aluminum may sometimes be affixed flush with the fabric. This thin aluminum sheet or foil may be made to conform to the various curved surfaces to which it is mounted, but all cuts and seams should be along lines radiating from the antenna base. A 7/16-inch hole should be punched in the center of this sheet for mounting the antenna. It is recommended that where necessary a metal reinforcing plate be provided to resist the bending load imposed by the slipstream. Do not lengthen or shorten the antenna. It has been cut the proper length for the most efficient radiation at the frequencies generated by this transmitter. The method of attaching the transmission line to the antenna is illustrated in Figure 4, page 24.

2-E,3. Antenna Cables.

The type VTP-17 transmitting antenna and the type VRP-15A receiving antenna are both normally supplied with 8-ft. lengths of 52-ohm coaxial transmission line, such as RG-58A/U. The alternate type of receiving antenna, type VRP-37, is complete with 30 feet of 52 ohm coaxial transmission line with an attached balun. The lengths of the transmitter antenna cables are critical; shortening or splicing is not recommended. Excess cable can be coiled in any convenient location, provided at least a 6-inch radius is used when coiling. Extra long cables can be obtained on special order from the factory, complete with end fittings, or can be assembled in the field. Note that the VRP-15A receiver antenna cable has a phono-type connector on the antenna end (VRP-37 has two lug terminals) and an auto-type connector on the set end. The transmitter antenna cable has a phono-type connector on the set end, and lug and clamp fittings on the antenna end. Thus the cables are not directly interchangeable at either end.

2-F. TRANSMITTER CHANNELS

2-F,1. Additional Channel Activation.

All Mark IV Superhomers are built to accommodate a maximum of 27 Transmitter Channels, requiring 27 frequency control crystals. If it is desired to convert a new or used Unit from 9 to 27 channels, it is only necessary to purchase a kit of 18 additional crystals, plug them into the sockets already provided and uncover the appropriate Transmitter Channel Selector Dial Numbers.

2-G. STATION LICENSE

The transmitter itself, as installed in the aircraft, requires a Private Aircraft Radio Station License. This license is obtained by filing FCC Form 404. Since this transceiver has been type-accepted by the FCC and entered on their list of type-accepted equipment as "Narco Type VHT-4", it must be identified as such on your FCC Form 404 Station License Application.

NOTE—See also Operators License Requirement under 3-B,4., page 14.

CAUTION: The VHF transmitter in this equipment is guaranteed to meet Federal Communications Commission approval only when NARCO crystals are used.

When ordering crystals for additional channels or replacements, state NARCO model number to insure getting properly correlated crystals.

Use of other than NARCO crystals will void manufacturers warranty.

2-H. INSTALLATION CHECK

2-H,1. Ignition Shielding.

While it is possible in some types of airplanes to get satisfactory noise-free reception, it is always advisable and frequently absolutely necessary to use properly-fitted ignition shielding. It has been found that such shielding when not in first class condition as to clean and tight joints, etc., can cause a lot of noise, particularly at VHF, so it is therefore urgently recommended that the ignition shielding system in the airplane in which the set is being installed be thoroughly inspected and overhauled at the time of installation.

SECTION 3
OPERATION

Figure 1
FRONT PANEL VIEW
Narco Superhomer Mark IV

3-A. RECEIVER

3-A,1. Power Switch and Volume Control.

The knob located nearest the bottom center of the Front Panel operates the Primary DC Power Switch and serves as an Audio Output Volume Control. In the fully counter-clockwise position, past the detent ("click"), all power to the Unit is off.

The Unit is turned on by rotating the knob clockwise past the detent. If after a warmup period of not more than about 30 seconds the knob is advanced clockwise about half way toward maximum, there should be a noticeable background noise (hiss) in the headphones or loudspeaker if no signal is being received.

3-A,2. Receiver Tuning.

The Receiver may be tuned to any channel frequency between 108.0 and 127.0 megacycles by operating the Crank Handle at the lower right of the Front Panel and observing the frequency setting in megacycles on the dial directly above the Crank. Accurate tuning to a given channel should be done by carefully centering on a transmitting station known to be on the desired channel, or by tuning to a crystal controlled transmitter channel within the Mark IV Unit as described under 3-A,3. below.

CAUTION—A positive stop is provided at each end of the tuning range. Damage may result if the Tuning Crank is forced beyond the stops.

3-A,3. Receiver Calibration.

Unless there happens to be a station known to be transmitting on the channel to which it is desired to tune a continuous tuning type receiver, it may be difficult to set the tuning accurately to the desired channel. Because the transmitter is required to be accurately tuned to the channel frequencies, the crystal controlled oscillator in the transmitter may be used as a calibration marker for the receiver. This feature is provided in the Mark IV Unit by operating the oscillator at low power with tone modulation. The small knob just above the left side of the Course Selector Dial, when pulled out, activates the receiver calibration marker feature. The receiver may be accurately tuned to any channel for which a crystal is provided in the transmitter. The procedure is as follows:

a. Turn the Transmitter Channel Selector Switch (Knob just below the center of the panel, with the channel numbers displayed in the vertical slot directly above it) to the desired channel.

b. Pull out the small knob just above the left side of the Course Selector Dial.

c. Adjust the receiver tuning in the vicinity of the desired signal until the special tone modulation is heard.

d. Accurately center the receiver tuning on the tone modulation.

e. Push in the small knob.

The receiver is now accurately tuned to the selected transmitter channel.

This feature is normally used for what is known as Simplex Operation where the Transmitter and Receiver are tuned to the same channel. However, this feature may also be used to set the Receiver for what is known as Cross Channel operation, where the Transmitter and Receiver are on different channels. When used for this purpose care must be taken to reset the transmitter to the channel on which transmission is to take place.

CAUTION NOTES

NOTE 1. BE SURE TO **PUSH IN** THE CALIBRATE SWITCH BEFORE ATTEMPTING TO TRANSMIT.

NOTE 2. BE SURE TO **RE-SET THE TRANSMITTER** TO THE DESIRED CHANNEL IF THE RECEIVER HAS BEEN SET FOR CROSS CHANNEL OPERATION.

NOTE 3. **DO NOT** OPERATE THE TRANSMIT **"PUSH-TO-TALK"** BUTTON TO ACTIVATE THE CALIBRATE FEATURE.

3-A,4. Available Channels.

The Receiver Covers all of the either 9 or 27 Transmitter Channels, 118.1 thru 123.0 Mc, available in the Mark IV Unit, and additional communication channels to 127 m.c. It also covers all of the Omni Navigation Frequencies, 108.0 thru 117.9 m.c. See Table of Channels 3-D., page 16.

3-B. TRANSMITTER

3-B,1. Channel Selection.

The Transmiter Channel Frequencies are accurately controlled by quartz crystals.

The desired channel is chosen by turning the Channel Selector Switch Knob, just below the center of the Front Panel, to the channel as indicated by the Numbers directly above the Knob. This Selector has no stops and may therefore be moved at will, in either direction, to a higher or lower channel number.

CAUTION—THE CHANNEL SELECTOR SWITCH SHOULD NOT BE LEFT IN A BLANK POSITION.

(A 9 Channel Unit has 19 blank positions and a 27 Channel Unit has one blank position.)

3-B,2. Transmission.

The transmitter is normally activated for transmission by a "PUSH-TO-TALK" button on the microphone, which operates a relay within the Mark IV Unit.

Proper use of the microphone is important for good transmission. The technique to be used depends somewhat on the type of microphone being used. Generally it is advisable to hold the microphone in an upright position, close to the mouth and speak with a firm full voice, without shouting. The best kind of microphone to use is the noise-cancelling type.

3-B,3. Range.

The range of reliable VHF radio transmission is limited to the approximate distance to the horizon. Therefore, the range increases rapidly as higher altitudes are attained. The table below will provide a basis for estimating the reliable range at various altitudes in flat country.

ALTITUDE	RANGE
Zero	15 miles
1,000 feet	25 miles
2,500 feet	40 miles
5,000 feet	60 miles
7,500 feet	70 miles
10,000 feet	75 miles

In hilly or mountainous country the reliable range depends upon a clear line-of-sight, unobstructed by intervening hills or mountains, between the airplane and the ground receiving station.

3-B,4. Operator's License.

The Federal Communications Commission requires that the operator of this transmitter hold a Restricted Radio-Telephone Operator Permit, or higher class license. This permit may be obtained by any U. S. citizen from the nearest field office of the F.C.C. No examination is required.

NOTE—See also station license requirements under 2-H, page 11.

3-B,5. Available Channels.

a. Nine Channel Unit.

121.5	121.7	121.9
122.1	122.5	122.6
122.7	122.8	123.0 megacycles

b. 27 Channel Unit

118.1	118.3	118.5	118.7	118.9
119.1	119.3	119.5	119.7	119.9
120.1	120.3	120.5	120.7	120.9
121.1	121.3	121.5	121.7	121.9
122.1	122.4	122.5	122.6	122.7
122.8	123.0	megacycles		

See Table of CHANNELS SERVICES under 3-D, page 16.

3-C. OMNI NAVIGATION

3-C,1. Omni Navigation Method.

Omni Navigation is accomplished by receiving a signal from a special kind of VHF Radio Station, at a known location, having information on the direction TO or FROM the station.

3-C,2. Indicator and Switch.

The indicating meter in the upper left portion of the panel serves both as a LEFT-RIGHT meter and a TO-FROM meter. The INDICATOR SWITCH which is in the upper center of the panel selects which function the meter is to perform, and indicates this selection by a flag which covers part of the meter scale in the TO-FROM position.

3-C,3. Course Selector.

The Course Selector at the lower left of the Front Panel has a single horizontal thumb wheel marked in degrees. To select a particular course, rotate the thumb wheel until the desired course appears under the index mark for the Course Selector. The Course Selector has figures for degrees every 30° from 0° to 360°. There are large sub-divisions at every 10° and small sub-divisions at every 5°.

To center the needle to read a course, simply rotate the dial until the indicator needle centers. The Course Selector may be rotated in either direction at will, because it has no stops.

3-C,4. Course to Station (Homing).

a. Turn the INDICATOR SWITCH clockwise until the TO-FROM flag snaps into position.

b. Tune to the desired omni-range station on the receiver dial. The code identification will be heard. Tune for maximum deflection of the meter (either TO or FROM).

c. Rotate the COURSE SELECTOR dial until the meter deflects to maximum in the TO direction.

d. Turn the INDICATOR SWITCH counter-clockwise to snap the flag away from the indicating meter.

e. Reset the COURSE SELECTOR dial to center the meter needle. The correct setting will show a TO indication when the TO-FROM flag is momentarily snapped into view, and the wrong setting will show a FROM indication.

f. Turn the airplane until the magnetic compass reads the same as the COURSE SELECTOR dial. The omni indications do not depend upon the attitude or heading of the airplane, but only upon its bearing to the ground station, and so will not change as the airplane is turned to the magnetic heading which corresponds to the bearing to the ground station.

g. Correct the heading from time to time as needed to keep the needle centered. The needle always points to the ground track to the station as shown by the COURSE SELECTOR dial (except when switched to TO-FROM).

h. When approaching close to the omni station, the needle may become so sensitive as to be difficult to hold to center. Notice the compass heading you have been flying in the approach, and fly by compass until far enough beyond the station to make it easy to hold center again. By switching to TO-FROM during this interval, the time of passing the station will be indicated by several oscillations between TO and FROM after which the needle will continue to point in the FROM direction. After passing the station, reset the COURSE SELECTOR dial, if a new course is desired. Switch away the TO-FROM flag, and keep the needle centered as before. The sensing does not change.

i. If, for some reason, the airplane gets appreciably off-course as indicated by the needle, the COURSE SELECTOR can be reset slightly to recenter the needle. This will establish a new track to the station which is a straight line from the off-course point to the station, and is somewhat shorter than flying back to the original course.

j. The difference between the course setting as indicated by the COURSE SELECTOR and the magnetic heading of the airplane necessary to keep the needle centered, is the wind correction angle (plus any errors in the compass), which will be found useful in estimating the wind velocity and direction.

3-C,5. Course from Station.

Any desired outbound course can be flown by setting the COURSE SELECTOR dial to the setting corresponding to the out-bound course, and starting to fly in this direction. The needle will point to the chosen ground track, and when switched to TO-FROM will read FROM.

As the distance from the station increases, the signal will gradually grow weaker, eventually reducing the needle sensitivity. When the signal becomes so weak that the code identification is getting noisy, and the needle will not deflect more than about ¼ inch from center when switched to TO-FROM, the courses are too weak to be reliable, and another stronger omni station should be found. It is well to check the receiver tuning when the signal gets weak to see that it is tuned for maximum signal.

3-C,6. Orientation.

The OMNI-RANGE system can be used for orientation (obtaining a "fix" when airplane location is in doubt).

Bearings to ground stations do not depend upon the attitude or heading of the airplane, and hence can be taken easily and accurately in rough air. No compass correction needs to be made.

To use the omni system for orientation, the following procedure is recommended:

a. Choose two omni stations for bearings which are as near 90° apart as possible, and which are strong enough to give reliable readings.

b. Tune in No. 1 omni station and check its code identification.

c. Rotate COURSE SELECTOR dial until the meter centers in the left-right INDICATOR position, and reads FROM when switched to TO-FROM.

d. Record the reading of the COURSE SELECTOR dial, and draw a line on the chart FROM the omni station in the direction of this reading.

e. Tune in No. 2 omni station, take a FROM bearing, and draw a line from No. 2 station.

f. You are at the intersection of these two lines.

g. Add other lines from other omni stations, as desired, to improve the accuracy of the "fix."

3-C,7. Available Channels.

The Mark IV Equipment will operate on any Omni Channel assigned within the United States. The even tenths megacycle channels from 108.0 thru 111.8 are normally assigned to Terminal Omni Facilities.

General Omni Facilities are assigned to both odd and even tenths megacycles from 112.0 thru 117.9 megacycles.

See Table of Channels under 3-D, below.

3-D. CHANNELS

3-D,1. Table of Channel Frequencies for VHF Communication and OMNI Navigation Services.

Channel Frequency Megacycles (mc)	Assigned Service
108.0 thru 111.9	Even tenths megacycles only. Terminal Visual Omni-directional Range (TVOR) Stations.
112.0 thru 117.9	Odd and Even tenths megacycles. Visual Omni-directional Range (VOR) Stations.
118.1 thru 121.3	Control Tower Frequencies, Specific Assignments, which may be used for Simplex Service.
121.5	EMERGENCY FREQUENCY.
121.7	Ground Control. Special Assignment.
121.9	Ground Control. Common Assignment.
122.1	Flight Service Stations.
122.4	Air to Ground, for Control Tower Frequencies. Special Assignment.
122.5	Control Tower Stations. Common Assignment.
122.6	Same as 122.4 above.
122.7	Same as 122.4 above.
122.8	UNICOM. At fields with no Control Tower.
123.0	UNICOM. At fields with Control Tower.

SECTION 4
CIRCUIT DESCRIPTION

4-A. RECEIVER

4-A,1. VHF Input Filter.

Under certain conditions there may be spurious responses from FM Broadcasting Stations. To avoid such spurious responses, a series tuned trap, C-419 and L-403, shunted across the Receiver Antenna Connector, X-101, tuned to 98 megacycles, has been incorporated.

4-A,2. Pre-Selector & Converter.

The VHF pre-selector section includes a tuned R.F. amplifier stage, V-101, a pentode converter, V-102, and a separate local oscillator, V-103. The oscillator is temperature compensated to keep drift to a minimum.

The tuning system is a three-gang permeability mechanism with a reduction gear drive. Positive stops are provided at each end of the range, arranged to prevent damage to the gears thru excessive pressure at the ends of the tuning range. The trimmer capacitors, C-101, C-102, and C-103, are mounted on the Coil Assembly containing L-101, L-102 and L-103. This Assembly is in turn mounted on the chassis in such a manner as to reduce drift resulting from chassis strains, etc.

4-A,3. I.F. Amplifier, Detector, AVC, ANL.

Two stages of high-gain I.F. amplification, V-104 and V-105, tuned to 7.0 megacycles, are followed by a diode detector (V-106, terminal 6). The AVC diode, (V-106, terminal 5), is delay-biased to raise the detector level for improved linearity, and to flatten the AVC characteristic. The AVC time constant is somewhat slower than would be used for communication purposes, but the omni-range system requires a slow AVC to prevent curved courses. The noise limiter, CR-101, is included to reduce pulse noise interference.

4-A,4. Audio.

The receiver detector signal is fed to the grid of the first audio tube (V-401), a high-gain pentode, along with the audio signal from the carbon microphone. The microphone current is derived from the cathode bias of the audio output stage (V-402) through a suitable filter network consisting of R-407, C-409 and R-408.

The plate circuit of the first audio stage, V-401, is resistance-coupled to the grid of the audio output stage, V-402, which is biased somewhat higher than normal so as to reduce the plate current drain. The plate of the audio output stage is connected to an output transformer, T-401, which has a low-impedance winding tapped to match a 3 to 6 ohm speaker voice coil or one or two pairs of 600-ohm headphones. This transformer also includes a high-impedance winding for modulating the VHF transmitter.

The transmit-receive relay, K-401, is arranged to attenuate the speaker in "transmit" and to insert a side tone attenuator in the headphone circuit.

4-B. TRANSMITTER

4-B,1. Oscillator and Amplifier.

Two type 12BY7-A pentodes, V-301 and V-302, are employed in the VHF transmitter. Third overtone crystals in the 30 Mc. range are used in the oscillator circuit, with the doubler tank, L-302, tuned to the second harmonic. L-303 broad-band couples the 60 Mc. energy into the Output Doubler (V-302) grid tank circuit, L-304. V-302 operates as a plate and screen modulated, frequency doubler stage. The plate tank circuit, L-305, and the antenna tank circuit, L-307 and C-311, are tuned in the 120 Mc. range, broad-band coupled by L-306 and L-308. L-309 couples the R.F. energy from the antenna tank circuit to the 50 ohm antenna connector, X-301.

4-B,2. Crystals.

The quartz crystals used in this transmitter have been designed specifically for operation with the tubes and circuitry employed. When ordering crystals for additional channels be sure to specify the frequency desired and the NARCO part number shown in the replacement parts list. Use of other than NARCO crystals will result in unsatisfactory operation, and will void manufacturer's warranty.

4-B,3. Receiver Calibrate Signal.

When the Receiver Calibrate Knob is pulled out the Transmitter Oscillator tube, V-301, operates at low power and is grid modulated by the Neon Tube, LM-301, on the frequency to which the Transmitter Channel Selector is set. The modulated signal is picked up by the receiver circuits without a direct interconnection. When the Calibrate signal is on, the gain of the receiver is reduced by raising the bias on the first I.F. Tube, V-104, to prevent possible receiver overloading.

4-C. OMNI

4-C,1. Omni Signal.

The audio omni signal appearing at the second detector of the receiver comprises three separate signals which are simply mixed together. These are:

a. Voice modulation. 200 to 2500 cycles (35% max. mod.).

b. Reference phase signal. (30% mod.) 9960 cycles sub-carrier, frequency-modulated ±480 cycles at 30 cycles, fixed phase angle.

c. 30-cycles variable phase (30% mod.) in which the phase angle with respect to the reference phase signal is equal to the bearing to the station.

The omni-range circuits of the receiver are required to measure the phase angle between the 30-cycle variable phase signal and the 30-cycle fixed reference phase signal.

4-C,2. Reference Phase Channel.

The 9960 cycle subcarrier component of the audio signal, which is frequency-modulated at a 30-cycles rate is amplified by the triode section of the tube which also contains the detector and AVC diodes, V-106. It is coupled to the limiter, V-201, thru a high-pass RC network to attenuate the 30-cycle and voice signals.

The limiting amplifier tube, V-201, is operated without fixed grid bias so as to saturate readily and thereby remove any amplitude modulation due to cross-modulation or propeller modulation. It operates the discriminator, CR-201 and CR-202 thru a discriminator transformer, T-201.

The discrimminator load is split into two equal halves to provide a push-pull input to V-203, and the differential detector.

4-C,3. Variable Phase Channel.

The 30-cycle component is taken from the plate circuit of V-106 and fed thru a 30-cycle RC-type bandpass filter to the grid of V-204A. This tube has both a plate and cathode load, and provides two equal phases, separated by 180°, to the course selector network.

The course selector network consists of a linear phase bridge with the course selector arm used to select any desired phase angle between 0° and 360°. The angle is displayed by a single dial and pointer. The pointer is the fiducial mounted on the front panel just over the Course Selector Dial.

The output of the course selector network is coupled to V-204B, which amplifies this signal and feeds, via an RC coupling network, to the two grids of the differential detector. Since this network is carefully balanced, both grids receive the same phase and amplitude of the variable phase signal from V-204B.

The switch, S-201, short circuits a phase-shifting capacitor when the indicating meter is used for LEFT-RIGHT information, and introduces a phase shift approaching 90° when the switch is opened in the TO-FROM position.

4-C,4. Metering Circuits.

The differential detector thus receives a push-pull signal from the reference phase channel, and a "parallel" signal from the variable phase signal. If these signals are exactly 90° apart in phase, they will add vectorially to the same total AC voltage on both grids, and will not cause the differential plate milliameter to deflect. If, however, they are not exactly 90° apart in phase, the variable channel signal will increase the total AC voltage on one of the grids while reducing it on the other. This will cause an unbalance in the plate currents to the two sections of the differential detector, which will cause the differential plate milliammeter to deflect away from the center. The direction in which the meter will move depends upon whether the phase relationship between the reference signal and the variable channel signal is above or below 90°.

A 2000-Mfd damping capacitor is connected across the meter to slow its response so as to take an average reading and thus prevent it from fluctuating rapidly enough to become difficult to fly.

4-D. POWER CIRCUITS

4-D,1. Location.

The Receiver, Transmitter, and Omni circuits require d.c. voltages higher than that of the nominal primary supply of 12 volts d.c. In many equipments, such voltages are supplied from a separate power unit.

In the Mark IV Equipment, the required voltages are obtained from circuits within the Unit itself.

4-D,2. Circuits.

The power supply employs a non-synchronous, interrupter type, vibrator. The primary input circuit includes a hash filter and a high-capacity electrolytic capacitor to aid in supplying the peak currents required by the vibrator system.

The vibrator operates a 115 cycles. All replacement vibrators must be identical to the original and bear the NARCO part No. M-64007-3. This vibrator is NOT INTERCHANGEABLE with the 115-cycle vibrators used in some of the other NARCO equipments.

The buffer, or limiting capacitor, is divided between the primary and the secondary of the transformer. This placement of a substantial part of the timing capacitance across the primary winding prevents starting difficulties and increases the vibrator life. Replacements for either timing capacitor should be identical to the originals, since they are held to closer tolerances than most capacitors of their types.

SECTION 5
MAINTENANCE

5-A. MECHANICAL ACCESS

5-A,1. Case.

The outer case of the Mark IV Equipment (which is not shown in the photos, except that it is partly visible in the cover photo) is usually permanently installed in the aircraft. To remove the Unit for Maintenance or Service, it is only necesary to un-plug the two Antenna Cables and the Audio Cable, disconnect the 12 volt d.c. line and remove the wing nut at the rear of the Case and Unit Assembly.

The Unit may now be pulled straight out of the Case, with the Front Panel and all Controls intact.

5-A,2. Shields.

a. With the Unit removed from the Case access to the bottom of the Power Supply Section at the rear is made by removing the bottom shield, which is held in place by a total of eleven screws.

b. Within the area covered by the bottom shield mentioned in a., above, there is an additional round shield covering the vibrator socket. This shield is tack-soldered in place to insure a good ground.

5-A,3. Crystals.

With the Unit removed from the Case, the Transmitter Frequency Control Crystals are readily available above the Chassis, just behind the right side of the Front Panel. The lamp socket immediately above the crystals is held in place by a spring-clip-bracket and may be easily removed for access to the Crystals.

5-A,4. Transmitter Channel Selector Dial.

If Transmitter Channel Frequencies are added, changed or deleted, access to the Transmitter Channel Selector Dial behind the Front Panel is required. The Front Panel may be removed by taking off the four knobs and the Crank, which are fastened with set-screws, and then removing the four black phillips head screws holding the Panel to the chassis.

5-A,5. Receiver Dial Cord.

Instructions for access to and replacement of the Receiver Dial Cord are given on page 28, along with Figure 9.

5-B. EQUIPMENT REQUIRED

5-B,1. For Receiver Alignment.

a. VHF Signal Generator, for I.F. Alignment at 7.0 megacycles.
General Radio, Type 1001-A, Standard Signal Generator, or equivalent.

b. VHF Signal Generator, for R.F. Alignment, 108 thru 127 megacycles, and other tests.
Hewlett-Packard 608-D or equivalent.

c. Audio wattmeter, General Radio Type 583-A or equivalent.

d. Vacuum Tube Voltmeter, A.C., Ballantine Model 300, or equivalent.

5-B,2. For Transmitter Tuneup.

a. R.F. Wattmeter, Impedance 50 ohms, Bird Electronic Corp., Model 61, or equivalent.

b. Vacuum Tube Voltmeter, D.C., RCA Voltohmist or equivalent.

5-B,3. For Omni Circuit Adjustments.

a. Vacuum Tube Voltmeter, A.C., Ballentine. (Same as 5-B,1,d., above).

b. Omni Signal Generator, Aircraft Radio Corp., Model H-14A, or equivalent.

c. For Phase Angle Measurements, four additional pieces of equipment are required, as is indicated in the TEST SETUP DIAGRAM, Figure 6, page 26.

5-C. RECEIVER

5-C,1. Alignment Procedure.

a. Connect the Signal Generator to the grid of the converter tube, V-102, terminal 1. Keep leads short.

b. Connect the Audio Wattmeter to the speaker output, X-401, terminal 4. Connect an AC VTVM to the junction of R-113, R-114, and C-121.

c. Set the Signal Generator to 7.0 Mc and reduce the output so that the AC VTVM indication is between 0.5 and 1.0 VAC.

d. Peak the tuning screws on all three IF transformers, T-101, T-102, and T-103. The primary tuning screws are at the top of the transformers. The secondary tuning screws are at the bottom of the transformers. With a signal level of 100 uv at the grid of the converter tube, V-102, there should be 0.30 VAC output.

CAUTION: *Do not adjust the RED transformer at this time.* This is an omni adjustment.

e. Disconnect the Signal Generator from the converter grid. Set the Signal Generator to 115.0 Mc and connect it to the Receiver Antenna Receptacle, X-101.

f. Tune in the 115.0 Mc signal and peak up the two trimmers, C-101, R.F. Input and C-102, Mixer Input. It may be necessary to retune the receiver slightly while peaking these two trimmers.

g. Reset the oscillator trimmer, C-103, only if the dial error is over 0.3 Mc and a signal of known frequency accuracy is available.

h. Check the audio output. There should be a minimum of 2.5 Watts output for an R.F. input signal of 10 microvolts, modulated 30%, at 1000 cps.

5-C,2. Performance Check.

CHECK	PROCEDURE	SIGNAL INPUT	NORMAL INDICATION
a. Overall	Connect RF Signal Generator to Receiver Antenna Connector. Connect Audio Wattmeter to Speaker Output.	10 Microvolts (108.0 thru 126.9 Mc) Modulated 30%, at 1000 c.p.s.	2.5 Watts Minimum
b. Sensitivity	Same as Overall Check.	1.5 Microvolts (108.0 thru 126.9 Mc) Modulated 30%, at 1000 c.p.s.	6 db $\frac{S+N}{N}$ or better
c. IF Gain	Connect RF Signal Generator to Pin 1 of V-102. Set Generator frequency to 7.0 Mc. Connect AC VTVM to Junction of R-113, R-114 and C-121.	100 Microvolts Modulated 30%, at 1000 c.p.s., at the grid of V-102.	0.30 VAC Minimum

NOTE: PERFORMANCE CHECKS MADE WITH A+ INPUT OF 13.75 VDC, MEASURED AT THE DC INPUT LEAD TO THE UNIT.

5-D. TRANSMITTER

5-D,1. Tuneup Procedure.

a. If the transmitter does not contain crystals for 118.1, 120.5 and 123.0 Mc, install crystals for these frequencies for alignment purposes. Set the transmitter selector to 123.0 Mc.

b. Connect a 50 ohm RF wattmeter to the transmitter output receptacle, X-301.

c. Connect a high impedance DC voltmeter or VTVM between terminal 2 of V-301 and ground, with a 1 megohm isolating resistor between the meter probe and terminal 2.

d. Press the microphone button to activate the transmitter.

e. Adjust L-301 for maximum voltmeter reading. If the meter indicates –50 volts, or more, proceed with step f. But if the reading is less than –50, move the probe and isolating resistor to terminal 2 of V-302 and check the oscillator grid voltage, which should be at least –8 volts. (Tune L-301 for maximum). Low oscillator grid voltage can be caused by a weak oscillator tube, low activity crystal, or low operating voltage.

f. With the voltmeter probe and isolating resistor on terminal 2 of V-301, rotate the channel selector dial and check to see whether the grid voltage remains approximately the same on the three alignment frequencies of 118.1 120.5, 123.0 Mc. If the voltage varies considerably, or is low, adjust L-302 and L-304 until approximately equal readings are obtained at 118.1, 120.5 and 123.0 Mc.

g. Noting the RF wattmeter readings, rotate the channel selector through the frequency range. If the indicated power output is essentially uniform across the band, and is approximately 1.0 watt minimum at each frequency, the transmitter is aligned properly. L-305 and L-307 should be adjusted until this condition exists. Lower than normal power output indicates a defective tube, insufficient grid driving voltage for V-301, defective components, or incorrect operating voltage.

5-D,2. Performance Check.

CHECK	PROCEDURE	NORMAL INDICATION
a. Overall	Connect RF Wattmeter to Transmitter antenna connector. Connect microphone to microphone jack. Key transmitter.	Minimum of 1 watt output on all activated frequencies.

NOTE: PERFORMANCE CHECK MADE WITH TRANSMITTER KEYED AND A+ INPUT OF 13.75 VDC, MEASURED AT THE DC INPUT LEAD TO THE UNIT.

5-E. OMNI

5-E,1. Meter Centering (Electrical).

a. Turn Equipment on and allow a reasonable time to warm up. Now tune the receiver to a position on the dial where no signal is being received. Set the DC input voltage at 13.75 volts DC.

b. Adjust the meter centering potentiometer (R-216) to center the L-R needle within the triangle at the center of the scale.

5-E,2. Discriminator Transformer (T-201) Adjustment.

a. Connect the AC VTVM to Terminal 5 of V-201.

b. Connect the output of the Omni Signal Generator (H-14A or equivalent) to the Receiver Antenna Jack, and set the Omni Signal Generator output to 9960 cycles. Tune the Receiver for maximum AC output voltage as indicated on the AC VTVM.

c. Turn the secondary (top) slug of T-201 all the way out. Tune the primary (bottom) slug for maximum AC voltage as indicated on the AC VTVM. Remove the AC VTVM from Terminal 5 of V-201.

d. Turn the secondary (top) slug of T-201 in noting the action of the L-R needle swing while tuning. As the slug is turned in, the meter will first swing left to maximum, then it will swing back through the center and then to the right to a maximum. At this point, back the slug out until the L-R needle is centered in the triangle at the center of the scale.

5-E,3. TO-FROM Balance.

a. Switch the Omni Signal Generator to the OMNI position. Set the OMNI TRACK dial to 0°. Set the Output Attenuator to 5 u volts. Set the Receiver Course Selector to 0° and the T-F/L-R switch to the T-F position.

b. The Indicator needle should swing left into the BLUE Sector, half scale or more. Set the Omni Signal Generator course heading to 180°. The needle should swing right into the YELLOW Sector an amount equal to that in the BLUE.

c. An unbalance should be compensated for by shunting R-209 or R-210 (terminals 5 and 6 or 7 and 8 on TB-102, the top terminal board) with a selected value of resistance between 560K and 4.7 megohm.

d. If compensation was necessary, the meter will require re-centering on the 9960 cycle frequency. It may be re-centered by readjusting the secondary slug of T-201 (as in paragraph 5-E,2,d., above)

5-E,4. Reciprocal Course Compensation.

a. Turn the L-R/T-F Switch to L-R. Set the Omni Signal Generator output at 500 microvolts on a course of 0°, with the modulation switch on the OMNI position.

b. Set the Receiver Course Selector Dial to 0°. Center the meter by the use of the Zero Set potentiometer, R-218. Switch the Omni Signal Generator to 180°, and note the L-R needle swing if any. If the needl swings into the BLUE sector, compensate by shunting R-213. If the needle swings into the YELLOW sector, compensate by shunting R-214. If compensation is required, the meter will require re-centering on 9960 cycles as in 5-E,2,d, above. Then, re-check for reciprocal error.

5-E,5. Overall Course Compensation.

a. Set the Receiver Course Selector Dial to 0°. Set the Omni Signal Generator to 0° and its attenuator output at 500 microvolts.

b. Determine that the L-R meter is centered with no signal applied, and also that it is centered with a 9960 cycle signal and with a normal OMNI signal applied.

c. Turn the Receiver Course Selector Dial to 180°. Turn the Omni Signal Generator to 180°. If the L-R Indicator centers with the course selector dial indicating a course higher than 180° (Example 185°), adjust the value of the selected resistor R-223 to move the 180° course to its proper place.

c. If the value of R-223 is changed, the meter will have to be recentered on a zero course heading by the use of the zero set potentiometer R-218.

Then, recheck the 180° course to avoid over or under compensation.

5-E,6. Performance Check.

CHECK	PROCEDURE	SIGNAL INPUT	NORMAL INDICATION
a. Course Accuracy	Connect Omni Simulator to Receiver Antenna Connector. Select and check at least the four Cardinal Points. (0°, 90°, 180°, and 270°).	500 Microvolts	±5° on the four cardinal points. (0°, 90°, 180°, and 270°).
b. TO-FROM Sensitivity	Connect Omni Simulator to Receiver Antenna Connector. Set Omni Simulator and Course Selector Dial to the course heading of 0°. Set the T-F/L-R switch to the T-F position. Check both TO and FROM.	5 Microvolts	Minimum of ½ scale deflection into each color sector.
c. Course Width	Connect Omni Simulator to Receiver Antenna Connector. Set Omni Simulator and Course Selector Dial to the course heading of 0°. Rotate the course selector dial either side of 0° heading to swing indicator to edges of color sectors.	500 Microvolts	25° maximum between outer edges of color sectors.
		5 Microvolts	50° maximum between outer edges of color sectors.

NOTE: PERFORMANCE CHECKS MADE WITH A+ INPUT OF 13.75 VDC, MEASURED AT THE DC INPUT LEAD TO THE UNIT.

SECTION 6
ILLUSTRATIONS

6-A. INTRODUCTION

This section contains the diagrams and photographs referred to in the previous sections, except for the overall schematic.

The overall schematic is on an extendable sheet at the rear of this manual. (Page 41, Figure 15.)

These illustrations are intended for general use in installation, service, and maintenance.

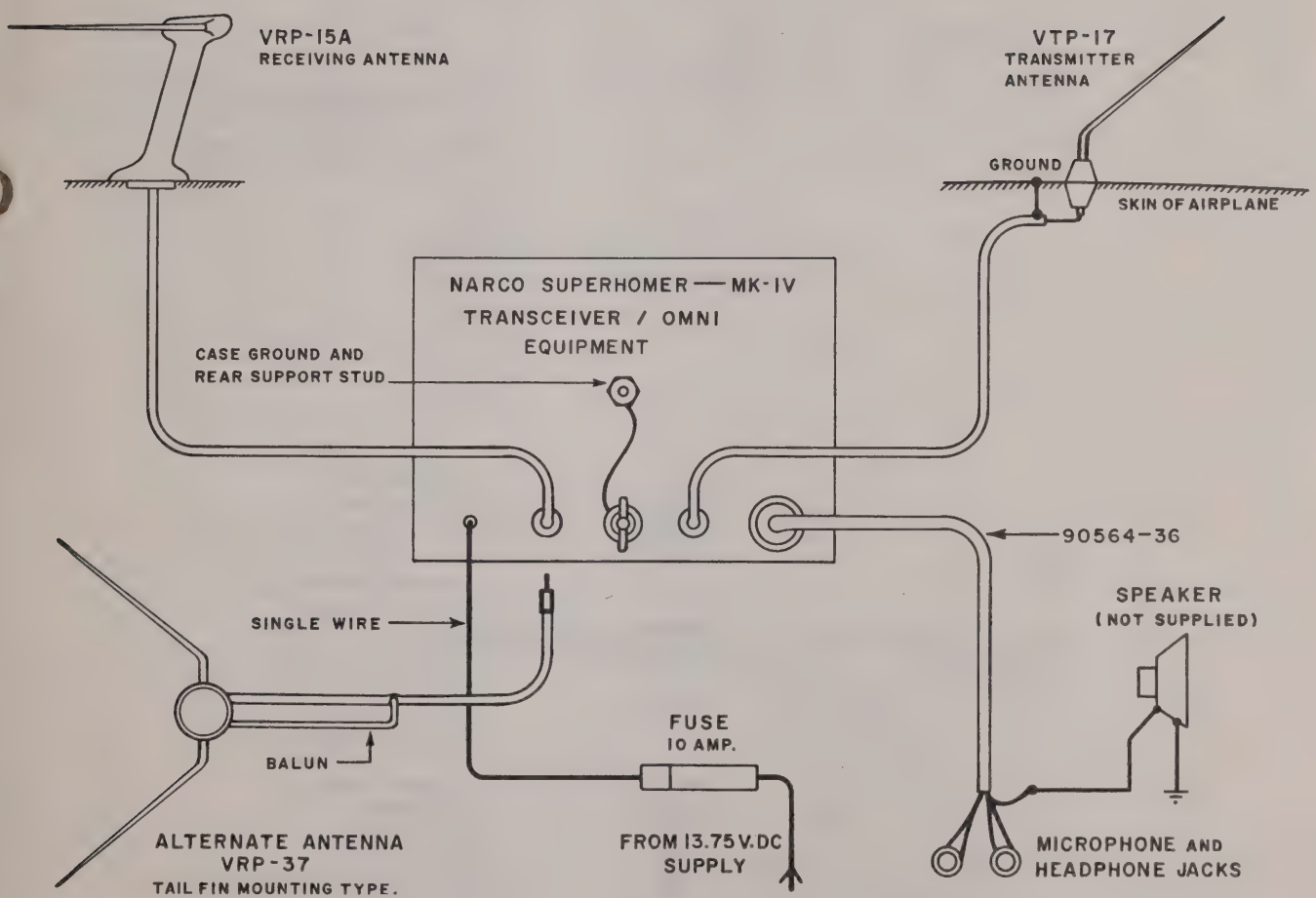


Figure 2
EQUIPMENT INTERCONNECTION DIAGRAM

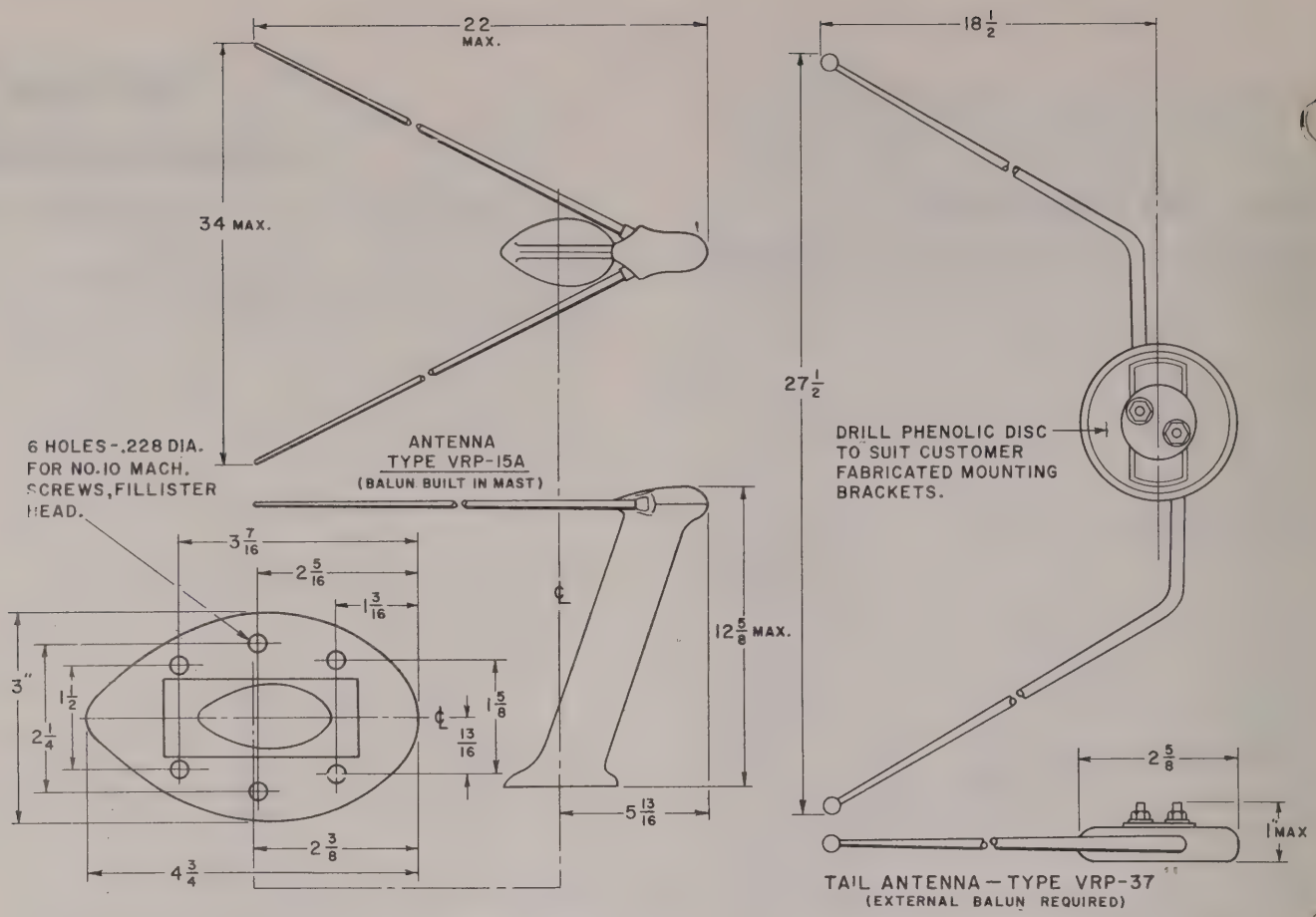


Figure 3
OMNI NAVIGATION/RECEIVING ANTENNA,
Installation Diagram

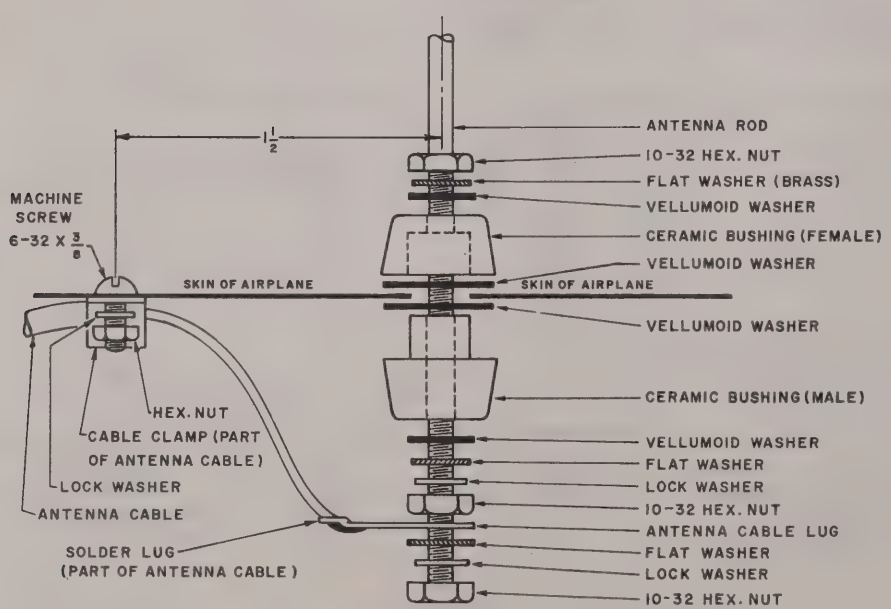


Figure 4
TRANSMITTER ANTENNA
Installation Diagram

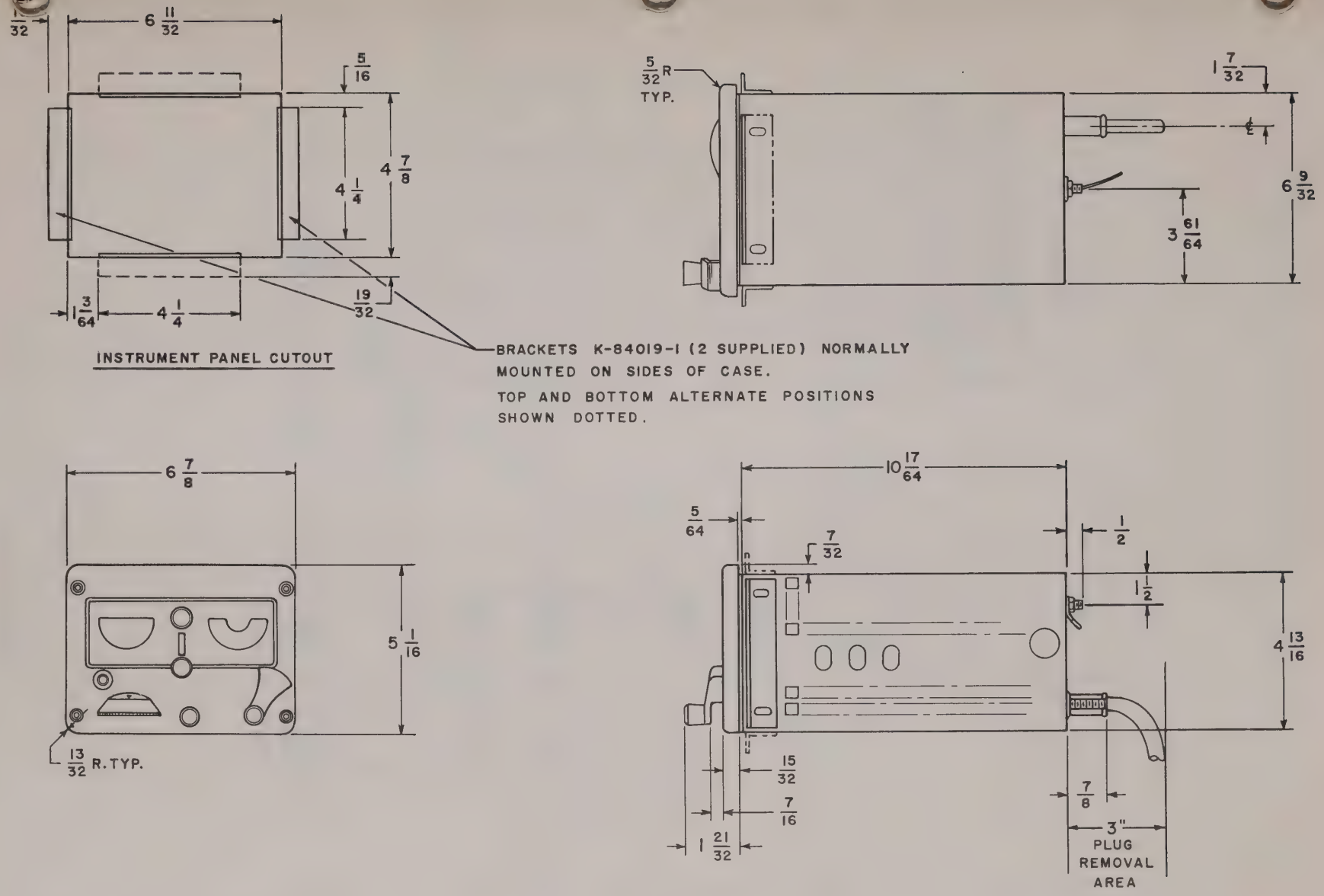


Figure 5
MECHANICAL INSTALLATION DIAGRAM
Narco Superhomer MK-IV

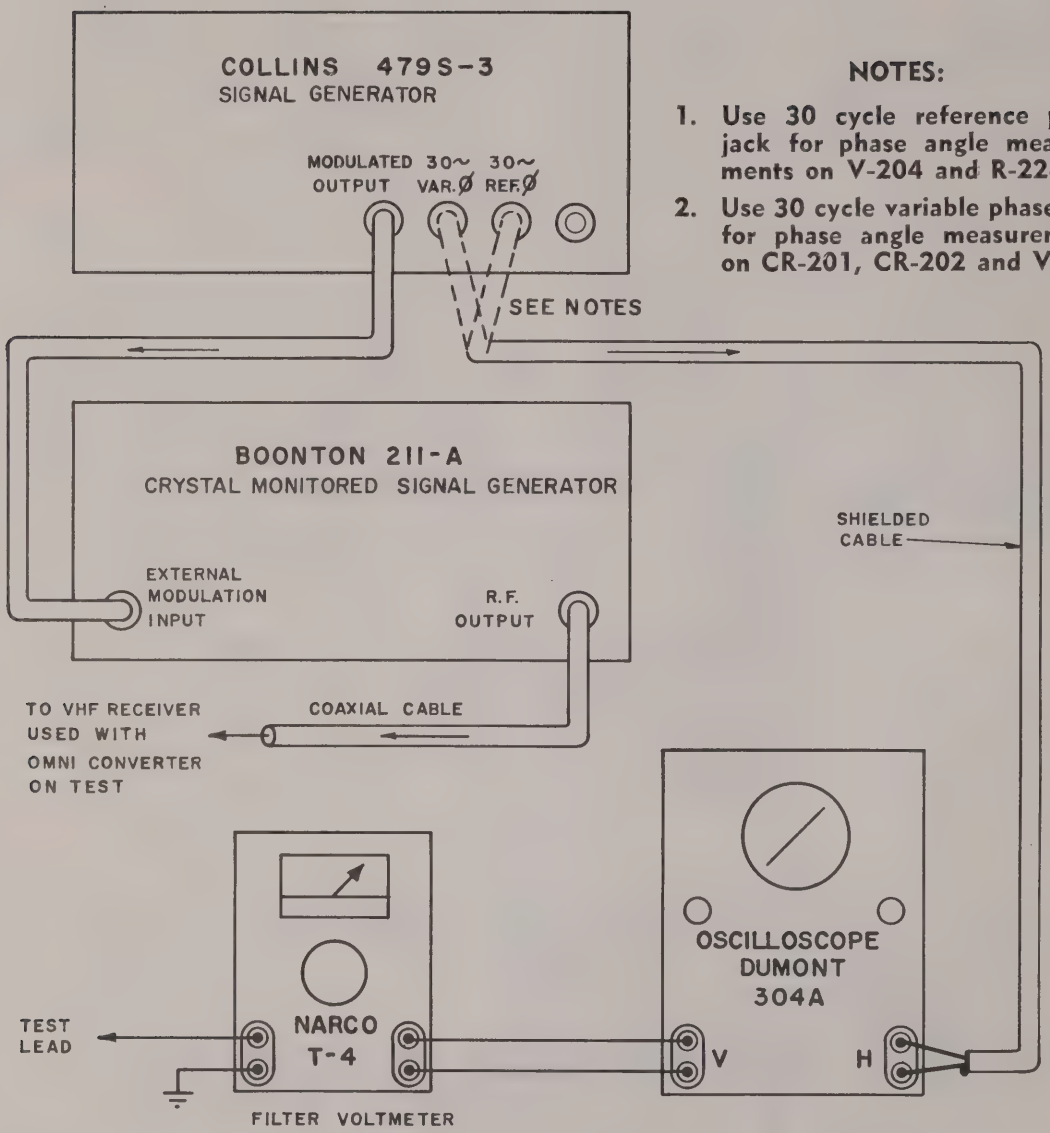


Figure 6

TEST SETUP
for
PHASE ANGLE MEASUREMENT

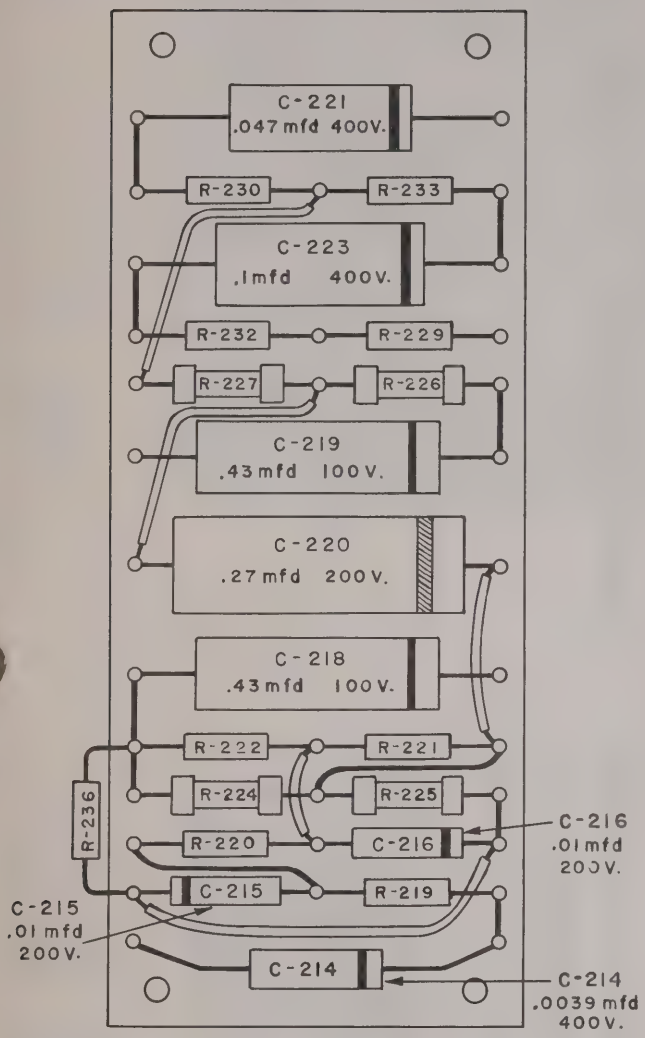


Figure 7

COMPONENT ASSEMBLY
TB-101
(Below Chassis)

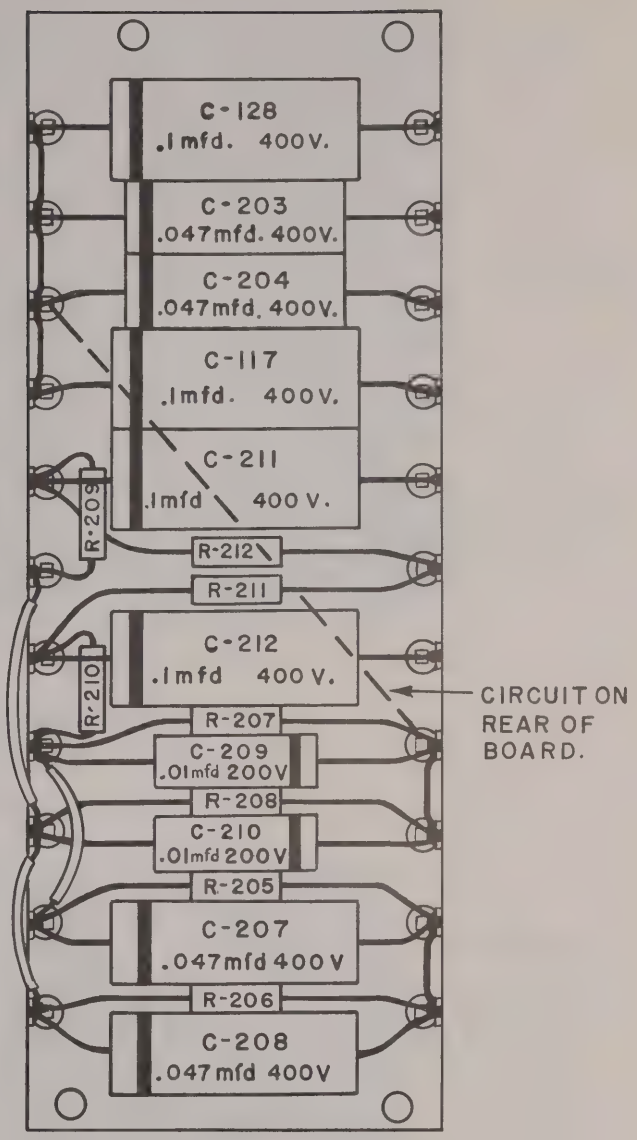


Figure 8

COMPONENT ASSEMBLY
TB-102
(Above Chassis)

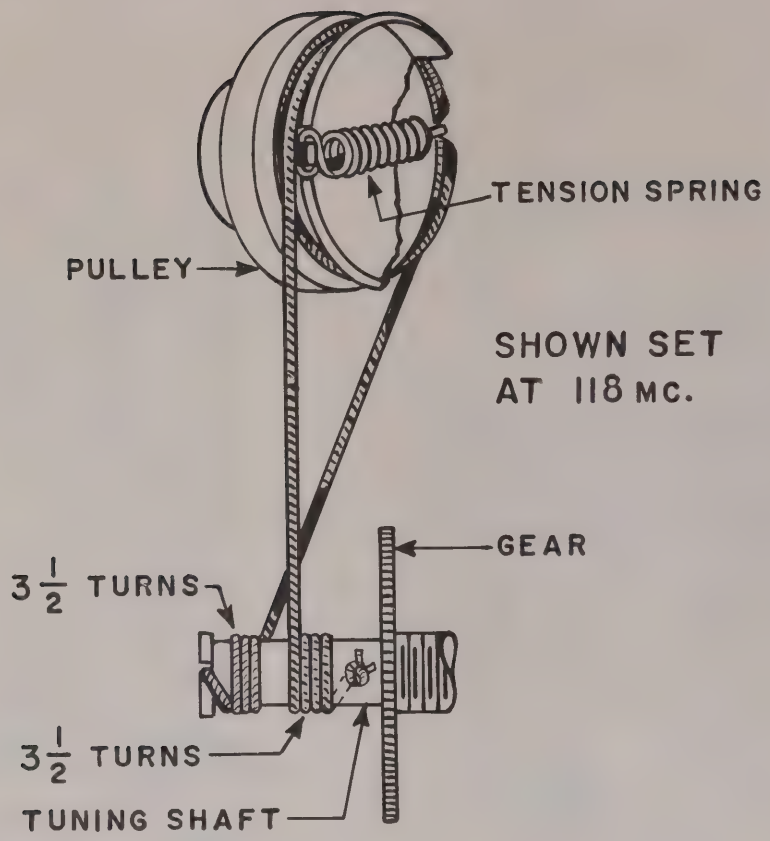


Figure 9

DIAL DRIVE RECEIVER TUNING

INSTRUCTIONS FOR REPLACING RECEIVER DIAL DRIVE CORD.

1. Remove the Unit from the Case.
2. Remove the front panel by removing the four knobs and the crank, which are fastened with set-screws, and then removing the four black Phillips-head screws holding the panel to the chassis.
3. Facing the front of the unit turn it bottom up so that the Tuner Assembly is near the upper left.
4. Remove the Pinion Gear Assembly by removing the four screws (two front and two rear) holding it in place.
5. Observe the slot at the front of the Tuner Assembly shaft and a hole thru the shaft behind the slot.
6. With a screwdriver cautiously turn the shaft clockwise (CW) until it comes to a stop.
7. Turn the shaft counter-clockwise (CCW) about ¼ turn or until the hole behind the slot is vertical, then continue CCW for 5½ turns.
8. Provide a suitable piece of dial cord, tie a knot in one end, pass the opposite end thru the hole in the shaft until the knot meets the shaft.
9. Turn the shaft CW 3½ turns thus winding 3½ turns of cord on the shaft. See Figure 9 above.
10. Now turn the Unit upright and continue with the cord for 2½ truns around the dial drum.
11. Again turn the Unit bottom up. Now wind 3½ turns of cord CCW on the shaft, then pass the cord thru the slot in the end of the shaft and make a knot in the cord.
12. With the Unit upright again, replace the take-up spring in the dial drum by pushing a turn of the cord thru the hole in dial drum, then hooking one end of the spring on the cord and the other end on the hook provided on the edge of the drum opposite the hole in the drum.
13. With the dial drum spring in place and the shaft in the position where there are 3½ turns of cord in each direction on the shaft, the receiver dial should indicate approximately 118 Mc. If it does not it may be re-positioned by loosening the screw at the center of the dial.
14. Replace the Pinion Gear Assembly.
15. For a frequency calibration re-check refer to the procedure under 5-C,1., paragraphs f. and g., page 20.
16. Replace the Front Panel, Knobs and Crank.

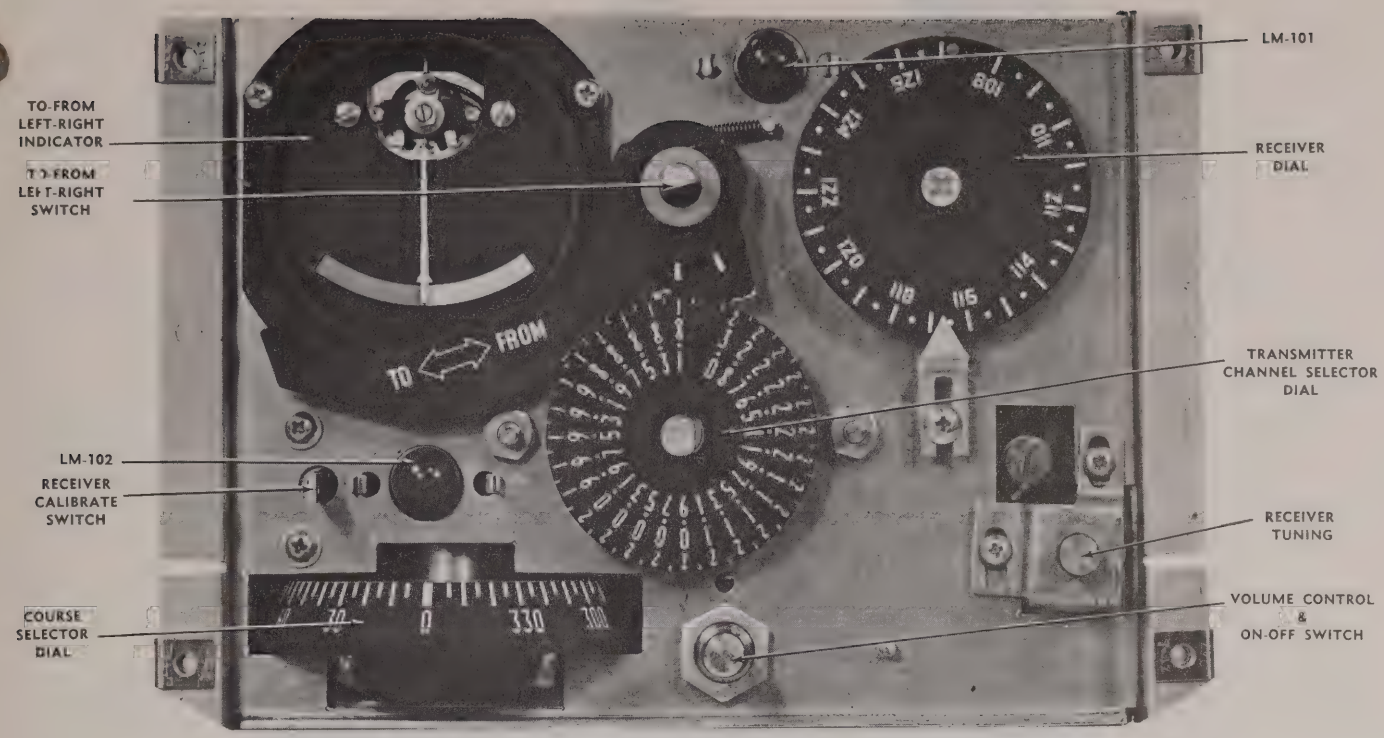


Figure 10

FRONT VIEW
Without Trim Panel

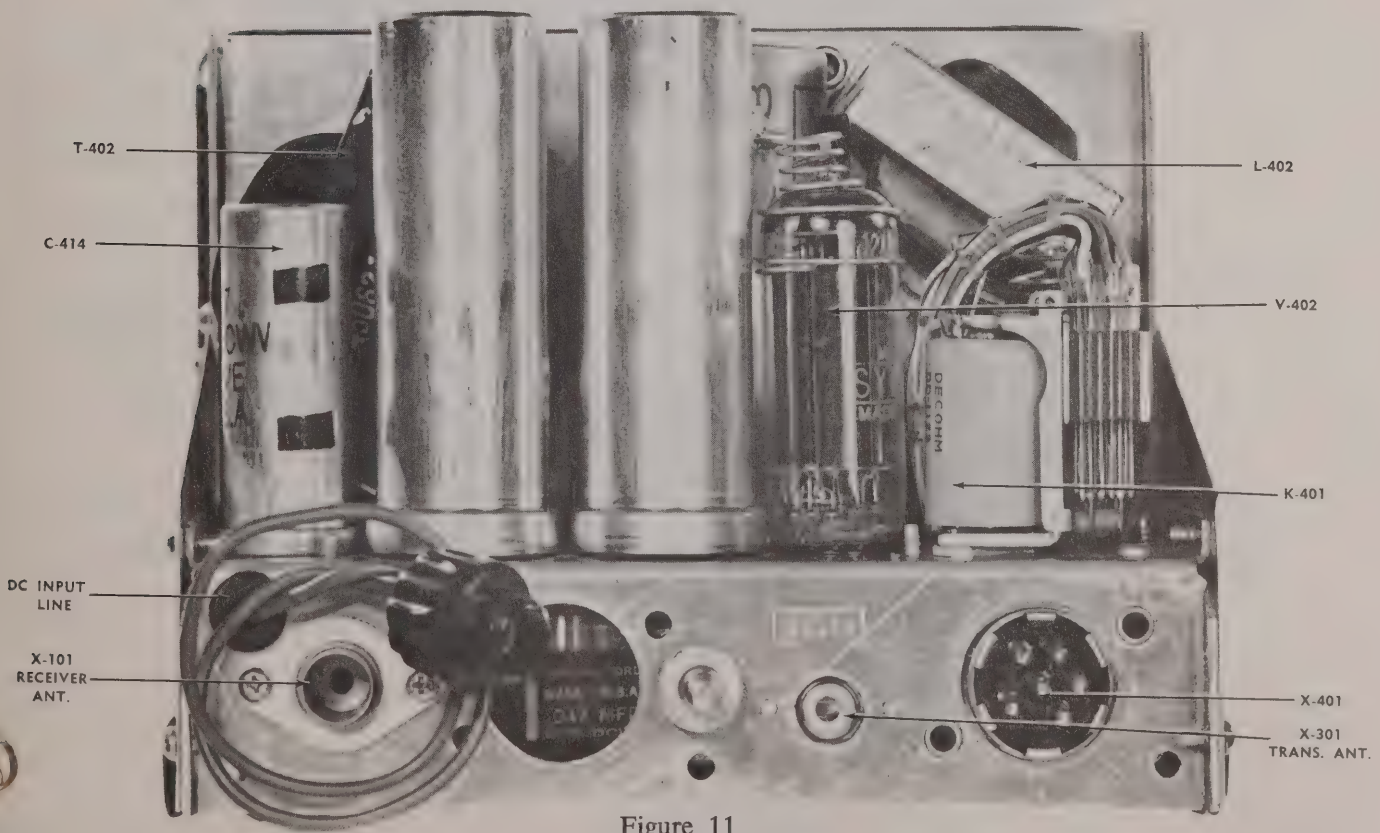


Figure 11

REAR VIEW
Without Case

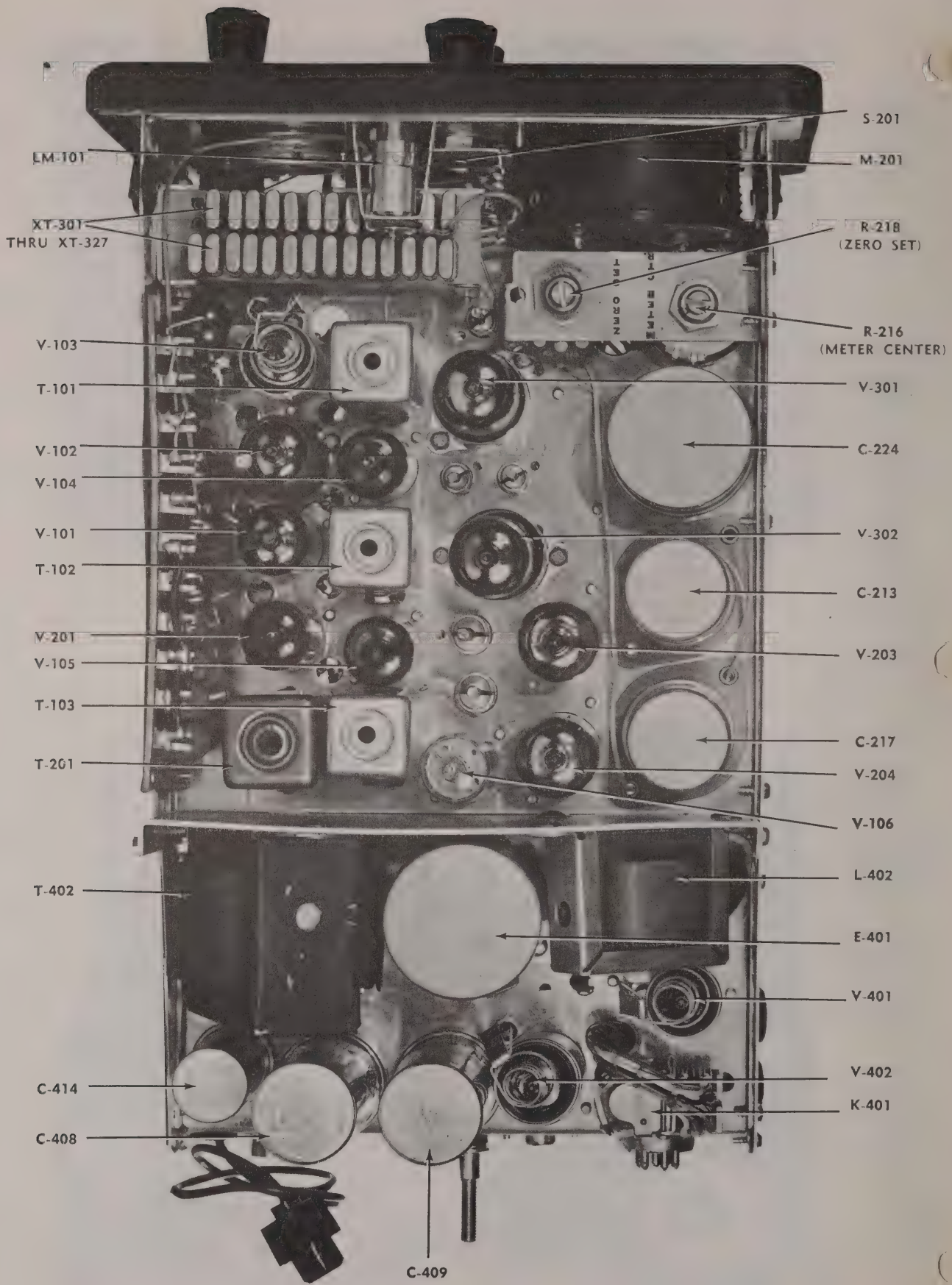


Figure 12
TOP VIEW,
Without Case.

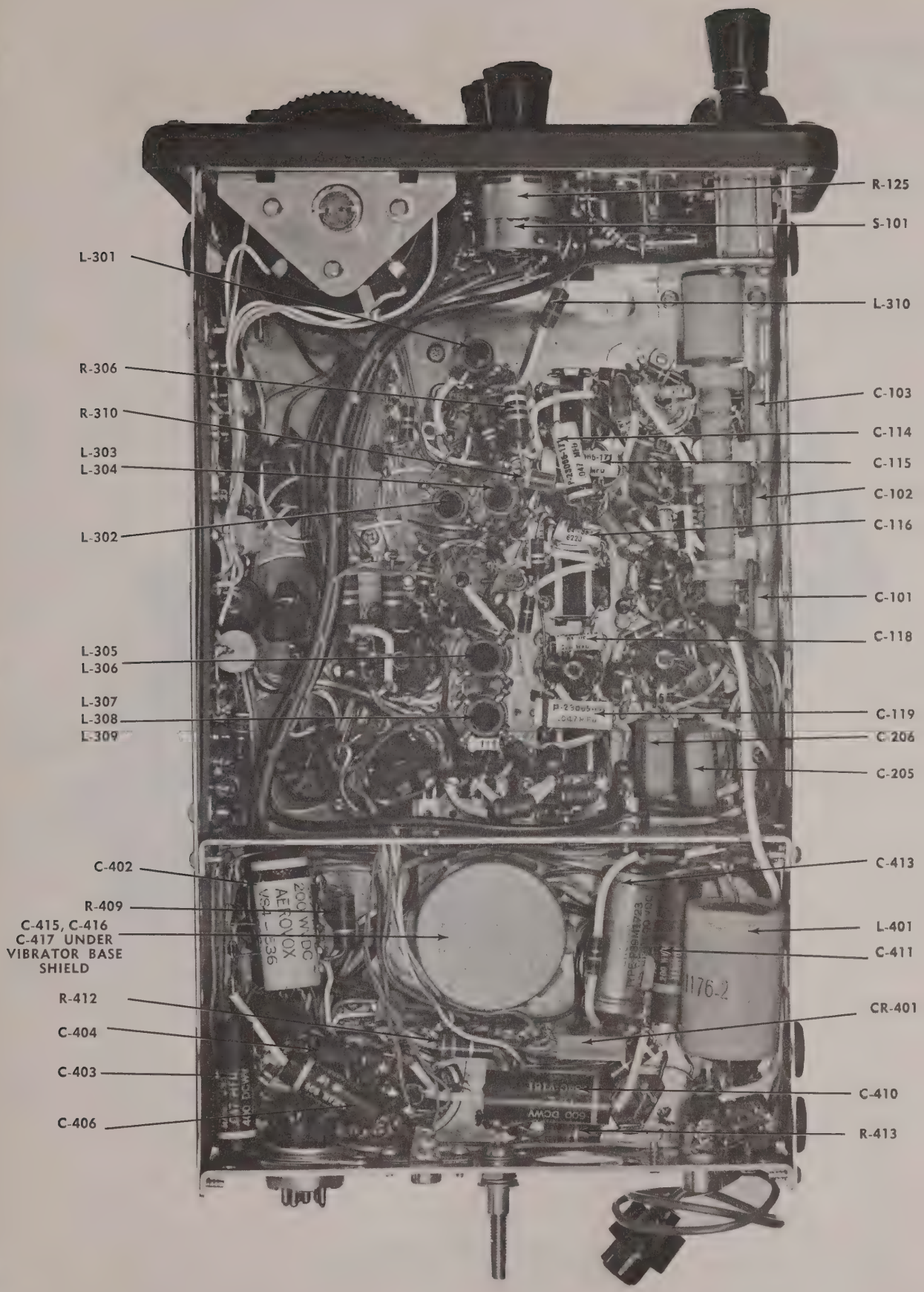


Figure 13
BOTTOM VIEW,
Without Case and Bottom Rear Shield.

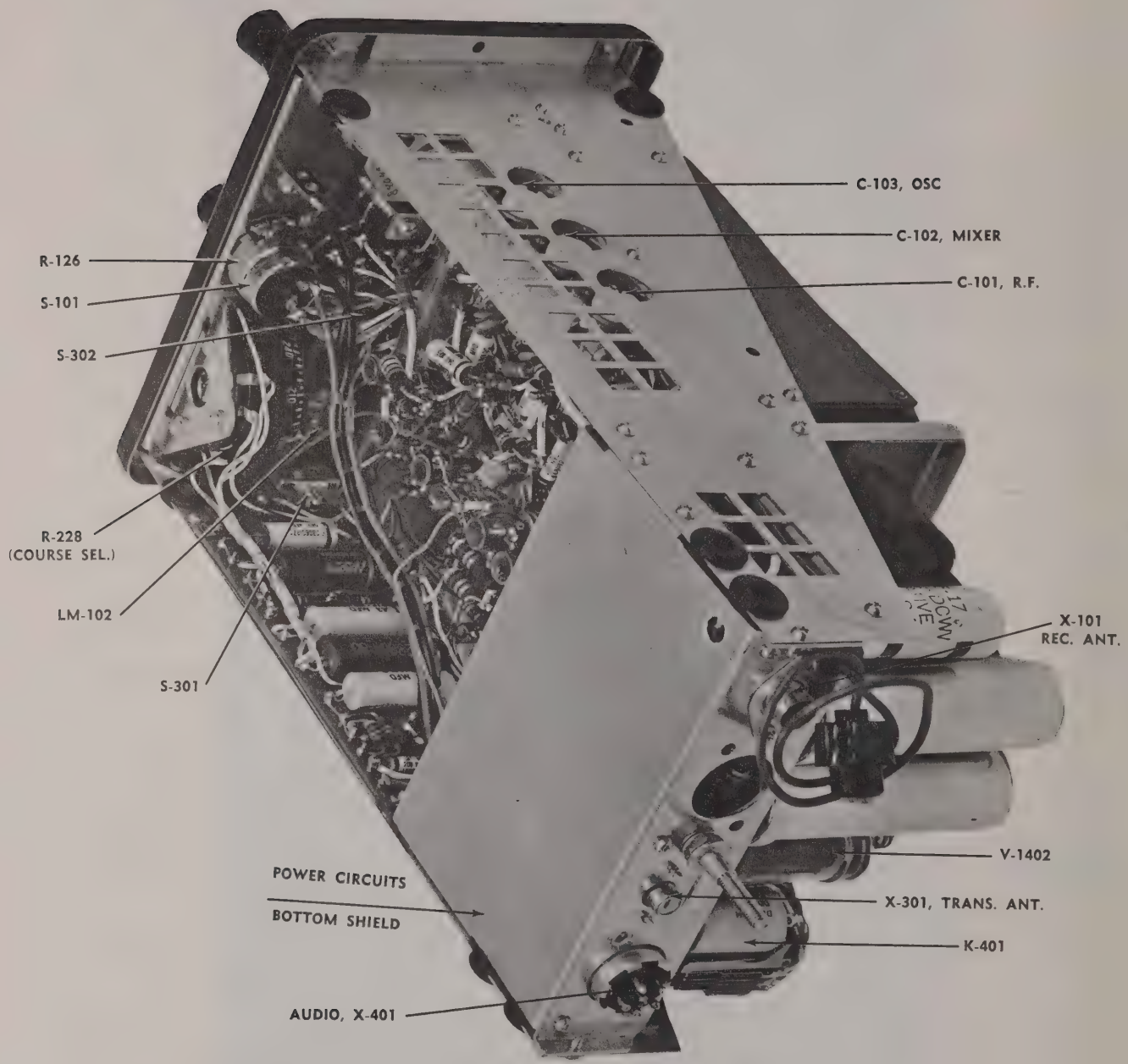


Figure 14

DIAGONAL VIEW

With Bottom Rear Shield in Place

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-101	11242-104	Capacitor, Ceramic	Part of Tuner Assy.
C-102	11242-104	Capacitor, Ceramic	Part of Tuner Assy.
C-103	11242-104	Capacitor, Ceramic	Part of Tuner Assy.
C-104	11242-104	Capacitor, Ceramic	Part of Tuner Assy.
C-105	21201-220	Capacitor, Ceramic, 500V, NPO, 22 mmf, ±10%	
C-106	21291-2	Capacitor, Ceramic Disc, 500V, 470 mmf, ±20%	
C-107	21201-220	Same as C-105	
C-108	11242-104	Capacitor	Part of Tuner Assy.
C-109	21201-220	Same as C-105	
C-110	21291-21	Capacitor, Ceramic Disc, 1000V, .001 mf	
C-111	21291-5	Capacitor, Ceramic Disc, 50V, .01 mf +80%, –30%	
C-112	21291-4	Capacitor, Ceramic Disc, 500V, .003 mf, +80%, –20%	
C-113	23065-113	Capacitor, Tubular Mylar, 200V, .01 mf ±20%	
C-114	23065-171	Capacitor, Tubular Mylar, 200V, .047 mf, ±10%	
C-115	23065-171	Same as C-114	
C-116	23065-113	Same as C-113	
C-117	23065-225	Capacitor, Tubular Mylar, 400V, .1 mf ±20%	
C-118	23065-113	Same as C-113	
C-119	23065-171	Same as C-114	
C-120	21308-101	Capacitor, Ceramic HIK, 500V, 100 mmf ±20%	
C-121	21308-101	Same as C-120	
C-122	21308-101	Same as C-120	
C-123	23065-159	Capacitor, Tubular Mylar, 200V, .0047 mf ±10%	
C-124	23065-113	Same as C-113	
C-125	21308-101	Same as C-120	
C-126	21308-221	Capacitor, Ceramic, HIK, 500V, 220 mmf ±20%	
C-127	21308-101	Same as C-120	
C-128	23065-225	Same as C-117	
C-129	21291-5	Same as C-111	
C-130	21291-5	Same as C-111	
C-131	21291-5	Same as C-111	
C-132	21291-5	Same as C-111	
C-133	21201-479	Capacitor, Ceramic, 500V, NPO, 4.7 mmf ±20%	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS (Continued)	
C-201	21308-221	Same as C-126	
C-202	21308-221	Same as C-126	
C-203	23065-221	Capacitor, Tubular Mylar, 400V, .047 mf ±20%	
C-204	23065-221	Same as C-203	
C-205	24041-123	Capacitor, Mica, 300V, .012 mf ±5% CM35	
C-206	24041-123	Same as C-205	
C-207	23065-221	Same as C-203	
C-208	23065-221	Same as C-203	
C-209	23065-213	Capacitor, Tubular Mylar, 400V, .01 mf ±20%	
C-210	23065-213	Same as C-209	
C-211	23065-225	Same as C-117	
C-212	23065-225	Same as C-117	
C-213	21525-3	Capacitor, Electrolytic, Prong Base, 0.1V, NP, 200 mf	Meter Damping
C-214	23065-258	Capacitor, Tubular Mylar, 400V, .0039 mf ±10%	
C-215	23065-113	Same as C-113	
C-216	23065-113	Same as C-113	
C-217	21525-5	Capacitor, Electrolytic, Prong Base, 250V, 40mf	
C-218	23077-1	Capacitor, Tubular Mylar, .43 mf ±1%, 100V	
C-219	23077-1	Same as C-218	
C-220	23064-80	Capacitor, Tubular Mylar, 200V, 27 mf ±10%	
C-221	23065-221	Same as C-203	
C-222	21524-5	Capacitor, Electrolytic, 6V, 50 mf	
C-223	23065-225	Same as C-117	
C-224	21525-20	Capacitor, Electrolytic, 350V, 40 mf, 200V, 20-80 mf	Hi-Volts B+ Filter Lo-Volts B+ Filter
C-225	23065-159	Same as C-123	
C-226	21308-101	Same as C-120	
C-227	21308-101	Same as C-120	
C-228	21291-5	Same as C-111	
C-301	21291-21	Same as C-110	
C-302	21291-21	Same as C-110	
C-303	21291-5	Same as C-111	
C-304	21291-4	Same as C-112	
C-305	21291-4	Same as C-112	
C-306	21291-4	Same as C-112	
C-307	21291-5	Same as C-111	
C-308	21291-21	Same as C-110	
C-309	21291-7	Capacitor, 1000V, HIK, 470 mmf	
C-310	21201-120	Capacitor, Ceramic, 500V, NPO, 12 mmf ±20%	
C-311	21291-5	Same as C-111	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS (Continued)	
C-401	21308-101	Same as C-120	
C-402	23065-183	Capacitor, Tubular Mylar, 200V, .47 mf ±20%	
C-403	23065-221	Same as C-203	
C-404	21319-202	Capacitor, Ceramic, 500V, GMV, 2K mmf	
C-405	21308-221	Same as C-126	
C-406	20064-213	Capacitor, Tubular Mylar, 600V, .01 mf ±20%	
C-407	21291-5	Same as C-111	
C-408	21525-16	Capacitor, Electrolytic C-408A-350V, 20 mf C-408B-350V, 20 mf C-408C-15V, 200 mf	B+ & MIC Voltage Filter
C-409	21525-16	Same as C-408	
C-410	23064-221	Capacitor, Tubular Mylar, 600V, .047 mf ±20%	
C-411	23064-79	Capacitor, Tubular Mylar, 200V, 22 mf ±10%	
C-412	21291-1	Capacitor, Ceramic Disc, 500V, 430 mmf	
C-413	21191-15	Capacitor, Tubular Oil, 1600V, .008 mf	Buffer Capacitor
C-414	21525-17	Capacitor, Electrolytic, 15V, 400 mf	
C-415	21173-105	Capacitor, Metallized, 200V, 1.0 mf	
C-416	21191-15	Same as C-412	
C-417	21191-15	Same as C-412	
C-418	21191-15	Same as C-412	
C-419		Capacitor, Part of L-403	VHF Input Filter
		D, DIODES	
CR-101	75013-1	Diode, Silicon 1N816	Noise Limiter
CR-201	75013-1	Same as CR-101	Ratio Det.
CR-202	75013-1	Same as CR-101	Ratio Det.
CR-401	75203-2	Diode, Silicon, Mallory FW-400	Bridge Rectifier Assembly
		CR-401A CR-401B Part of CR-401 CR-401C CR-401D	Combination of 4 units (A, B, C, and D)
		E, MISC. ELEC. PTS. (VIBRATORS)	
E-401	64007-3	Vibrator, 12 volts, 115 cycles	DC to DC Converter

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		J. JACKS (CONNECTORS)	
		(See Receptacles Under X, page 39, and Miscellaneous, page 40.)	
		K, RELAY	
K-401	65126-18	Relay, 4PDT, 12 Volt Coil	
		L, INDUCTORS	
L-101	11242-104	Part of Assembly Tuner	
L-102	11242-104	Part of Assembly Tuner	
L-103	11242-104	Part of Assembly Tuner	
L-104	11138-9	Choke, RF, Insulated, 2.2 uhy	
L-105	11138-5	Choke, RF, Insulated, .47 uhy	
L-106	11138-5	Same as L-105	
L-107	11138-5	Same as L-105	
L-301	11374-101	Coil	Oscillator Screen
L-302	11370-101	Coil	Doubler Plate
L-303	11376-101	Coil	Interstage Coupling
L-304	11376-101	Assembly	Final Grid Coil
L-305	11377-101	Coil	Final Plate
L-306	11377-101	Part of L-305	Interstage Coupling
L-307	11397-101	Coil	Output
L-308	11397-101	Part of L-307	Interstage Coupling
L-309	11397-101	Part of L-307	Antenna Coupling
L-310	11138-26	Choke, RF, Insulated, .56 uhy	
L-401	11176-2	Choke	RF, Hash
L-402	11173-1	Choke, 4 hy	B+ Filter
L-403	11198-1	Coil, Trap	VHF Filter
		LM, LAMPS	
LM-101		Panel Lamp, (Red) Mazda #53	Front Panel Lamp
LM-102		Same as LM-101	
LM-301		Neon Lamp, GE NE-2	Receiver Calibrate
		M, METERS	
M-201	76032-5	Meter,	Left-Right, To-From Indicator

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION

P, PLUGS (Connectors)

(See Receptacles Under X, page 39, and Miscellaneous, page 40.)

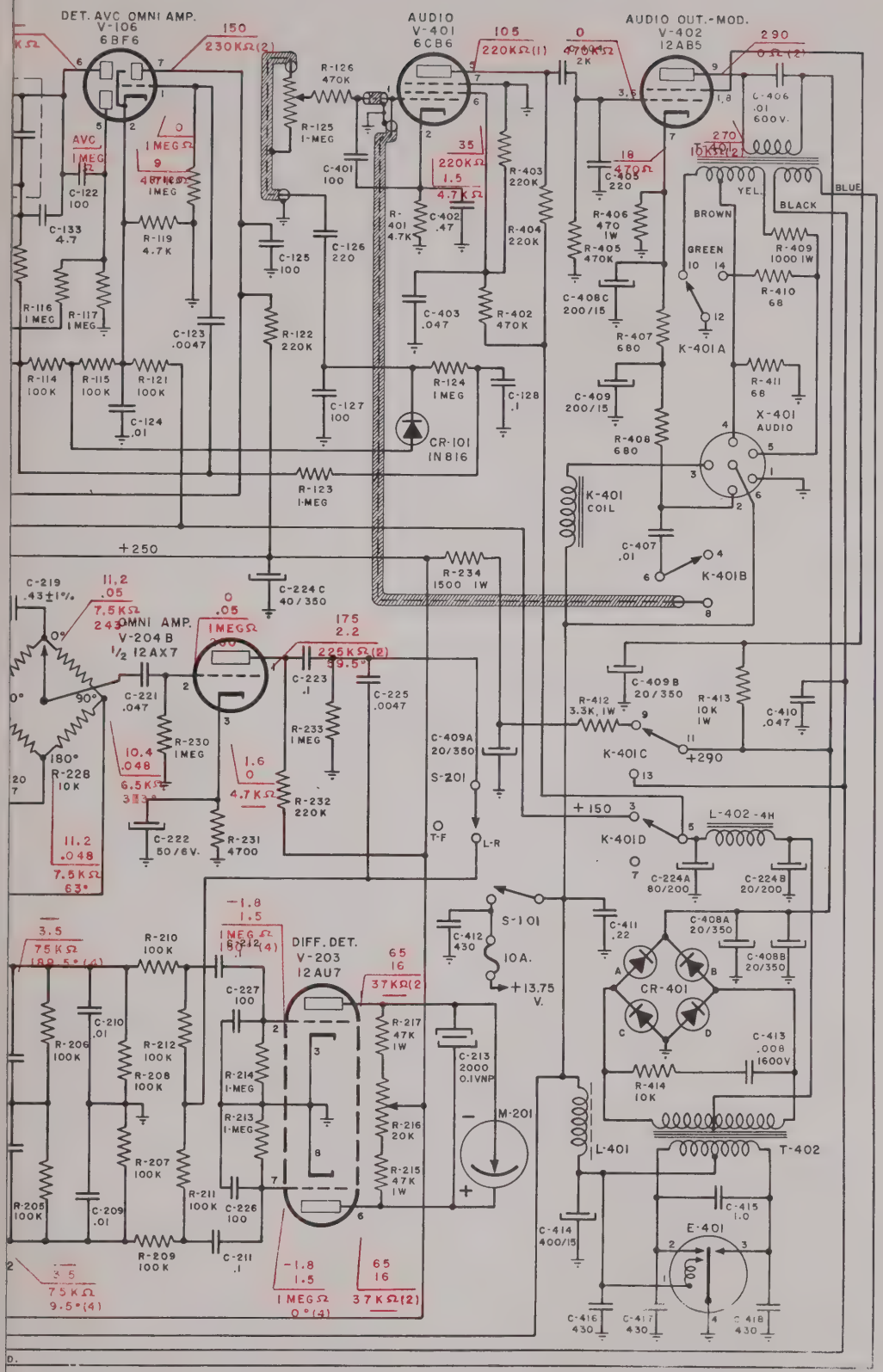
R, RESISTORS

R-101	31141-104	Resistor, Carbon, ½ Watt, 100K ohms ±10%	
R-102	31141-151	Resistor, Carbon, ½ Watt, 150 ohms ±10%	
R-103	31141-151	Same as R-102	
R-104	31141-104	Same as R-101	
R-105	31141-102	Resistor, Carbon, ½ Watt, 1K ohms ±10%	
R-106	31141-473	Resistor, Carbon, ½ Watt, 47K ohms ±10%	
R-107	31141-331	Resistor, Carbon, ½ Watt, 330 ohms ±10%	
R-108	31141-105	Resistor, Carbon, ½ Watt, 1 megohm ±10%	
R-109	31141-151	Same as R-102	
R-110	31141-151	Same as R-102	
R-111	31141-151	Same as R-102	
R-112	31141-681	Resistor, Carbon, ½ Watt, 680 ohms ±10%	
R-113	31141-103	Resistor, Carbon, ½ Watt, 10K ohms ±10%	
R-114	31141-104	Same as R-101	
R-115	31141-104	Same as R-101	
R-116	31141-105	Same as R-108	
R-117	31141-105	Same as R-108	
R-118		Not Used	
R-119	31141-472	Resistor, Carbon, ½ Watt, 4.7K ohms ±10%	
R-120	31141-105	Same as R-108	
R-121	31141-104	Same as R-101	
R-122	31141-224	Resistor, Carbon, ½ Watt, 220K ohms +10%	
R-123	31141-105	Same as R-108	
R-124	31141-105	Same as R-108	
R-125	32013-2	Resistor, Variable, with Switch, 1 megohm	Volume Control
R-126	31141-474	Resistor, Carbon, ½ Watt, 470K ohms ±10%	
R-201	31141-105	Same as R-108	
R-202	31141-105	Same as R-108	
R-203	31141-473	Same as R-106	
R-204	31141-273	Resistor, Carbon, ½ Watt, 27K ohms ±10%	
R-205	31141-104	Same as R-101	
R-206	31141-104	Same as R-101	
R-207	31141-104	Same as R-101	
R-208	31141-104	Same as R-101	
R-209	31141-104	Same as R-101	
R-210	31141-104	Same as R-101	
R-211	31141-104	Same as R-101	
R-212	31141-104	Same as R-101	
R-213	31141-105	Same as R-108	
R-214	31141-105	Same as R-108	
R-215	31135-473	Resistor, Carbon, 1 Watt, 47K ohms ±10%	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		R, RESISTORS (Continued)	
R-216	32007-2	Resistor, Variable, Nut & Lock Washer, 20K ohms	D.C. Centering
R-217	31135-473	Same as R-215	
R-218	32024-1	Resistor, Variable, 500K ohms	Zero Set
R-219	31141-564	Resistor, Carbon, ½ Watt, 560K ohms ±10%	
R-220	31141-225	Resistor, ½ Watt, 2.2 megohms ±10%	
R-221	31141-105	Same as R-108	
R-222	31141-105	Same as R-108	
R-223	31141-	Resistor, Carbon, ½ Watt, ±10%	Selected
R-224	31177-103	Resistor, Carbon, ½ Watt, 10K ohms ± 1%	
R-225	31177-123	Resistor, Carbon, ½ Watt, 12K ohms ±1%	
R-226	31177-103	Same as R-224	
R-227	31177-123	Same as R-225	
R-228	32038-1	Resistor, Potentiometer	Course Selector
R-229	31141-224	Same as R-122	
R-230	31141-105	Same as R-108	
R-231	21141-472	Same as R-119	
R-232	31141-224	Same as R-122	
R-233	31141-105	Same as R-108	
R-234	31135-152	Resistor, Carbon, 1 Watt, 1500 ohms ±10%	
R-235	31141-154	Resistor, Carbon, ½ Watt, 150K ohms ±10%	
R-236	31141-823	Resistor, Carbon, ½ Watt, 82K ohms ±10%	
R-237	31141-103	Same as R-113	
R-301	31141-223	Resistor, Carbon, ½ Watt, 22K ohms ±10%	
R-302	31141-106	Resistor, Carbon, ½ Watt, 10 megohms ±10%	
R-303	31141-104	Same as R-101	
R-304	31141-104	Same as R-101	
R-305	31141-680	Resistor, Carbon, ½ Watt, 68 ohms ±10%	
R-306	31135-393	Resistor, Carbon, 1 Watt, 39K ohms ±10%	
R-307	31141-154	Same as R-235	
R-308	31141-680	Same as R-305	
R-309	31141-222	Resistor, ½ Watt, 2200 ohms ±10%	
R-310	31135-333	Resistor, Carbon, 1 Watt, 33K ohm ±10%	
R-401	31141-472	Same as R-119	
R-402	31141-474	Same as R-126	
R-403	31141-224	Same as R-122	
R-404	31141-224	Same as R-122	
R-405	31141-474	Same as R-126	
R-406	31135-471	Resistor, Carbon, 1 Watt, 470 ohms ±10%	
R-407	31141-681	Same as R-112	
R-408	31141-681	Same as R-112	
R-409	31135-102	Resistor, Carbon, 1 Watt, 1000 ohms ±10%	
R-410	31141-680	Same as R-305	
R-411	31141-680	Same as R-305	
R-412	31135-332	Resistor, Carbon, 1 Watt, 3.3K ohms ±10%	
R-413	31135-103	Resistor, Carbon, 1 Watt, 10K ohms	V-402 Screen
R-414	31141-103	Same as R-113	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		S, SWITCHES	
S-101		Switch, (Part of R-125)	DC ON-OFF
S-201	61270-1	Switch, Rotary, SPDT	TO-FROM/LEFT-RIGHT
S-301	61119-4	Switch, Push-Pull, DPDT	Receiver Calibrate
S-302	61373-1	Switch, Rotary	Transmitter Channel Selector
		T, TRANSFORMERS	
T-101	11398-102	Transformer, IF, 7.0 megacycle	Input Transformer
T-102	11398-102	Same as T-101	Interstage Transformer
T-103	11398-102	Same as T-101	Output Transformer
T-201	11365-101	Transformer	Discriminator
T-401	11166-2	Transformer	Audio Output
T-402	11396-101	Transformer	Vibrator, 12 Volts
		ELECTRON TUBES	
V-101		Tube, Type 6BH6	R. F. Amp.
V-102		Same as V-101	Converter
V-103		Same as V-101	Oscillator
V-104		Same as V-101	First IF Amp.
V-105		Same as V-101	Second IF Amp.
V-106		Tube, Type 6BF6	Det. Avc. Omni Amp.
V-201		Same as V-101	Limiter
V-202		Not Used	
V-203		Tube, Type 12AU7	Diff. Det.
V-204		Tube, Type 12AX7	Omni Amp. & Phase Splitter
V-301		Tube, Type 12BY7-A	Osc. Doubler
V-302		Same as V-301	Doubler Output
V-401		Tube, Type 6CB6	Audio/Mic Amp.
V-402		Tube, Type 12AB5	Audio Output/Mod.
		X, SOCKETS (Receptacles)	
X-101	41143-1	Receptacle	Receiver Antenna
X-301	41110-2	Receptacle	Transmitting Antenna
X-401	41112-2	Receptacle, 6 pin male	Audio Cable

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		XT, CRYSTALS	
XT-301	72006-230	Crystal, for 118.1 mc	Frequency Control
XT-302	72006-231	Crystal, for 118.3 mc	Frequency Control
XT-303	72006-232	Crystal, for 118.5 mc	Frequency Control
XT-304	72006-233	Crystal, for 118.7 mc	Frequency Control
XT-306	72006-235	Crystal, for 119.1 mc	Frequency Control
XT-307	72006-236	Crystal, for 119.3 mc	Frequency Control
XT-308	72006-237	Crystal, for 119.5 mc	Frequency Control
XT-309	72006-238	Crystal, for 119.7 mc	Frequency Control
XT-310	72006-239	Crystal, for 119.9 mc	Frequency Control
XT-311	72006-240	Crystal, for 120.1 mc	Frequency Control
XT-312	72006-241	Crystal, for 120.3 mc	Frequency Control
XT-313	72006-242	Crystal, for 120.5 mc	Frequency Control
XT-314	72006-243	Crystal, for 120.7 mc	Frequency Control
XT-315	72006-244	Crystal, for 120.9 mc	Frequency Control
XT-316	72006-245	Crystal, for 121.1 mc	Frequency Control
XT-317	72006-246	Crystal, for 121.3 mc	Frequency Control
XT-318	72006-247	Crystal, for 121.5 mc*	Frequency Control
XT-319	72006-248	Crystal, for 121.7 mc*	Frequency Control
XT-320	72006-249	Crystal, for 121.9 mc*	Frequency Control
XT-321	72006-250	Crystal, for 122.1 mc*	Frequency Control
XT-322	72006-251	Crystal, for 122.4 mc*	Frequency Control
XT-323	72006-252	Crystal, for 122.5 mc*	Frequency Control
XT-324	72006-253	Crystal, for 122.6 mc*	Frequency Control
XT-325	72006-254	Crystal, for 122.7 mc*	Frequency Control
XT-326	72006-255	Crystal, for 122.8 mc*	Frequency Control
XT-327	72006-256	Crystal, for 123.0 mc*	Frequency Control
	72017-101	KIT, Basic, 9 Crystals, Marked * Above	
	72017-102	KIT, 18 Crystals, Supplement to Basic KIT 72017-101 for full 27 Channel Complement	
		*This is one of the 9 Crystals in the Basic Crystal Kit 72017-101	
		MISCELLANEOUS — (NO SYMBOL)	
	41117-1	Connector	Amphenol 91MPF-6L
	41127-1	Phone Jack with hardware	Switchcraft No. 11
	41128-1	Mike Jack with hardware	Switchcraft No. 5-12B
	41147-3	Socket, Miniature Bayonet	
	42030-3	Socket, 9 pin, Miniature, Mica filled phenolic	
	42034-1	Socket, 9 pin, Miniature, Bakelite	
	42033-2	Socket, 7 pin, Miniature, Bakelite	
	42033-4	Socket, 7 pin, Miniature, White Ceramic	
	42043-2	Socket, Vibrator	
	84019	Bracket, Case	
	90564-36	Cable, Audio	
	91013-3	Marker Sleeve	



ALL VOLTAGE, RESISTANCES, AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE OTHERWISE NOTED.

MEASUREMENTS TAKEN UNDER THE FOLLOWING CONDITIONS:

RECEIVER AND AUDIO

A+ INPUT OF 13.75 VDC. RF SIGNAL INPUT MODULATED 30% AT 1000 CPS AT A LEVEL OF 500 MICROVOLTS. OUTPUT TO SPEAKER 2 WATTS.

TRANSMITTER

A+ INPUT OF 13.75 VDC. WITH TRANSMITTER KEYED.

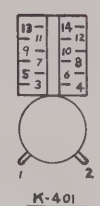
OMNI

A+ INPUT OF 13.75 VDC. SIGNAL INPUT FROM OMNI SIMULATOR AT A 500 MICROVOLT LEVEL. COURSE SELECTOR DIAL SET TO A COURSE OF 0°.

THE FOLLOWING SYMBOLS ARE USED FOR VOLTAGE, RESISTANCE AND PHASE ANGLE READINGS:

DC VOLTAGE / RESISTANCE — RECEIVER, AUDIO AND TRANSMITTER

DC VOLTAGE / AC VOLTAGE / RESISTANCE / PHASE ANGLE — OMNI



NOTES:

(1.) MEASURED TO TERMINAL 5 OF K-401

(2.) MEASURED TO TERMINAL 11 OF K-401

(3.) MEASURED TO TERMINAL 13 OF K-401

(4.) MEASURED WITH V-204 REMOVED FROM IT'S SOCKET.

Figure 15

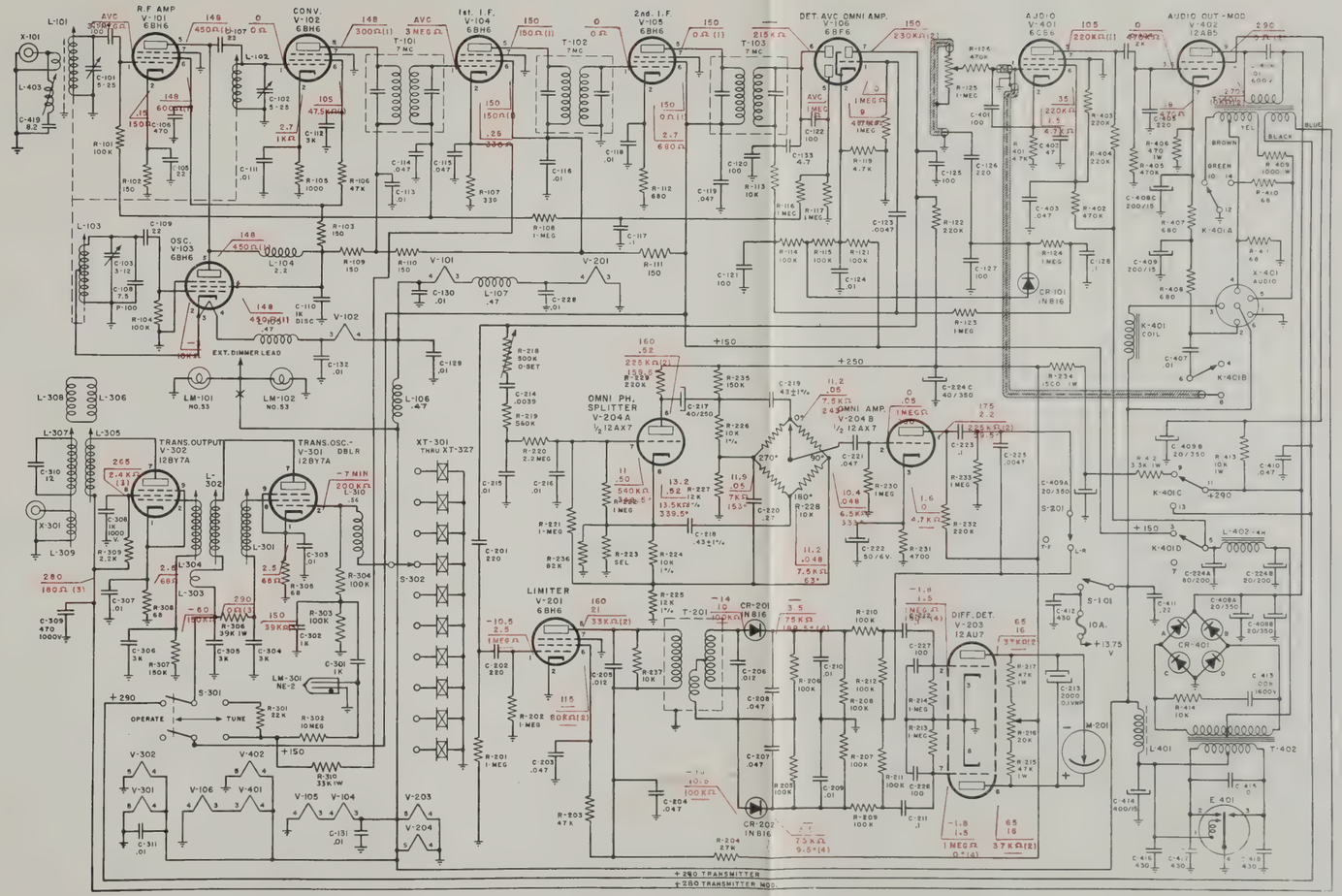
SCHEMATIC, NARCO SUPERHOMER MK-IV
CN83-A

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		XT, CRYSTALS	
XT-301	72006-230	Crystal, for 118.1 mc	Frequency Control
XT-302	72006-231	Crystal, for 118.3 mc	Frequency Control
XT-303	72006-232	Crystal, for 118.5 mc	Frequency Control
XT-304	72006-233	Crystal, for 118.7 mc	Frequency Control
XT-306	72006-235	Crystal, for 119.1 mc	Frequency Control
XT-307	72006-236	Crystal, for 119.3 mc	Frequency Control
XT-308	72006-237	Crystal, for 119.5 mc	Frequency Control
XT-309	72006-238	Crystal, for 119.7 mc	Frequency Control
XT-310	72006-239	Crystal, for 119.9 mc	Frequency Control
XT-311	72006-240	Crystal, for 120.1 mc	Frequency Control
XT-312	72006-241	Crystal, for 120.3 mc	Frequency Control
XT-313	72006-242	Crystal, for 120.5 mc	Frequency Control
XT-314	72006-243	Crystal, for 120.7 mc	Frequency Control
XT-315	72006-244	Crystal, for 120.9 mc	Frequency Control
XT-316	72006-245	Crystal, for 121.1 mc	Frequency Control
XT-317	72006-246	Crystal, for 121.3 mc	Frequency Control
XT-318	72006-247	Crystal, for 121.5 mc*	Frequency Control
XT-319	72006-248	Crystal, for 121.7 mc*	Frequency Control
XT-320	72006-249	Crystal, for 121.9 mc*	Frequency Control
XT-321	72006-250	Crystal, for 122.1 mc*	Frequency Control
XT-322	72006-251	Crystal, for 122.4 mc*	Frequency Control
XT-323	72006-252	Crystal, for 122.5 mc*	Frequency Control
XT-324	72006-253	Crystal, for 122.6 mc*	Frequency Control
XT-325	72006-254	Crystal, for 122.7 mc*	Frequency Control
XT-326	72006-255	Crystal, for 122.8 mc*	Frequency Control
XT-327	72006-256	Crystal, for 123.0 mc*	Frequency Control
	72017-101	KIT, Basic, 9 Crystals, Marked * Above	
	72017-102	KIT, 18 Crystals, Supplement to Basic KIT 72017-101 for full 27 Channel Complement	

*This is one of the 9 Crystals in the Basic Crystal Kit 72017-101

MISCELLANEOUS — (NO SYMBOL)

41117-1	Connector	Amphenol 91MPF-6L
41127-1	Phone Jack with hardware	Switchcraft No. 11
41128-1	Mike Jack with hardware	Switchcraft No. 5-12B
41147-3	Socket, Miniature Bayonet	
42030-3	Socket, 9 pin, Miniature, Mica filled phenolic	
42034-1	Socket, 9 pin, Miniature, Bakelite	
42033-2	Socket, 7 pin, Miniature, Bakelite	
42033-4	Socket, 7 pin, Miniature, White Ceramic	
42043-2	Socket, Vibrator	
84019	Bracket, Case	
90564-36	Cable, Audio	
91013-3	Marker Sleeve	



ALL VOLTAGE, RESISTANCES, AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE OTHERWISE NOTED.
MEASUREMENTS TAKEN UNDER THE FOLLOWING CONDITIONS:

RECEIVER AND AUDIO

A+ INPUT OF 13.75 VDC. RF SIGNAL INPUT MODULATED 30% AT 1000 CPS AT A LEVEL OF 500 MICROVOLTS. OUTPUT TO SPEAKER 2 WATTS.

TRANSMITTER

A+ INPUT OF 13.75 VDC. WITH TRANSMITTER KEYED.

OMNI

A+ INPUT OF 13.75 VDC. SIGNAL INPUT FROM OMNI SIMULATOR AT A 500 MICROVOLT LEVEL. COURSE SELECTOR DIAL SET TO A COURSE OF 0°.

THE FOLLOWING SYMBOLS ARE USED FOR VOLTAGE, RESISTANCE AND PHASE ANGLE READINGS:

DC VOLTAGE / RESISTANCE — RECEIVER, AUDIO AND TRANSMITTER

DC VOLTAGE / AC VOLTAGE / RESISTANCE / PHASE ANGLE — OMNI

NOTES:
(1.) MEASURED TO TERMINAL 5 OF K-401
(2.) MEASURED TO TERMINAL 11 OF K-401
(3.) MEASURED TO TERMINAL 13 OF K-401
(4.) MEASURED WITH V-204 REMOVED FROM IT'S SOCKET.

Ref. T-02172-F

Figure 15
SCHEMATIC, NARCO SUPERHOMER MK-IV
CN83-A

Superhomer MK-IV

Type VHT-4

VHF COMMUNICATION
and
OMNI NAVIGATION EQUIPMENT

Supplement No. 1
for
MAINTENANCE MANUAL

INTRODUCTION

This supplement covers certain improvements made in equipments manufactured after October, 1962. The significant changes are as follows:

C-407 was 0.01 microfarad.
LM-301 was NE-2.
R-107 was 330 ohms.
R-219 was 560K ohms.
R-301 was 22K ohms.
R-415 was added.

Contents:

Schematic, Figure 15A, page 45 Extension.

REPLACEMENT PARTS LIST

Corrections:
C-415 P/N 21401-105.
L-101 P/N 11242-106.
L-102 P/N 11242-106.
L-103 P/N 11242-106.
L-304 Descript.: Part of L-303.
XT-305 P/N 72006-234 for 118.9 mc.
XT-322 Delete asterisk(*)

Changes:
C-407 P/N 21319-202. Same as C-404.
LM-301 Descript., Neon Lamp, G.E. NE-2AT.
R-107 P/N 31141-471, Carbon ½W., 470 ohms, ±10%.
R-219 P/N 31141-Sel. Carbon, ½W., ±10%,
R-301 P/N 31141-103—Same as R-113.

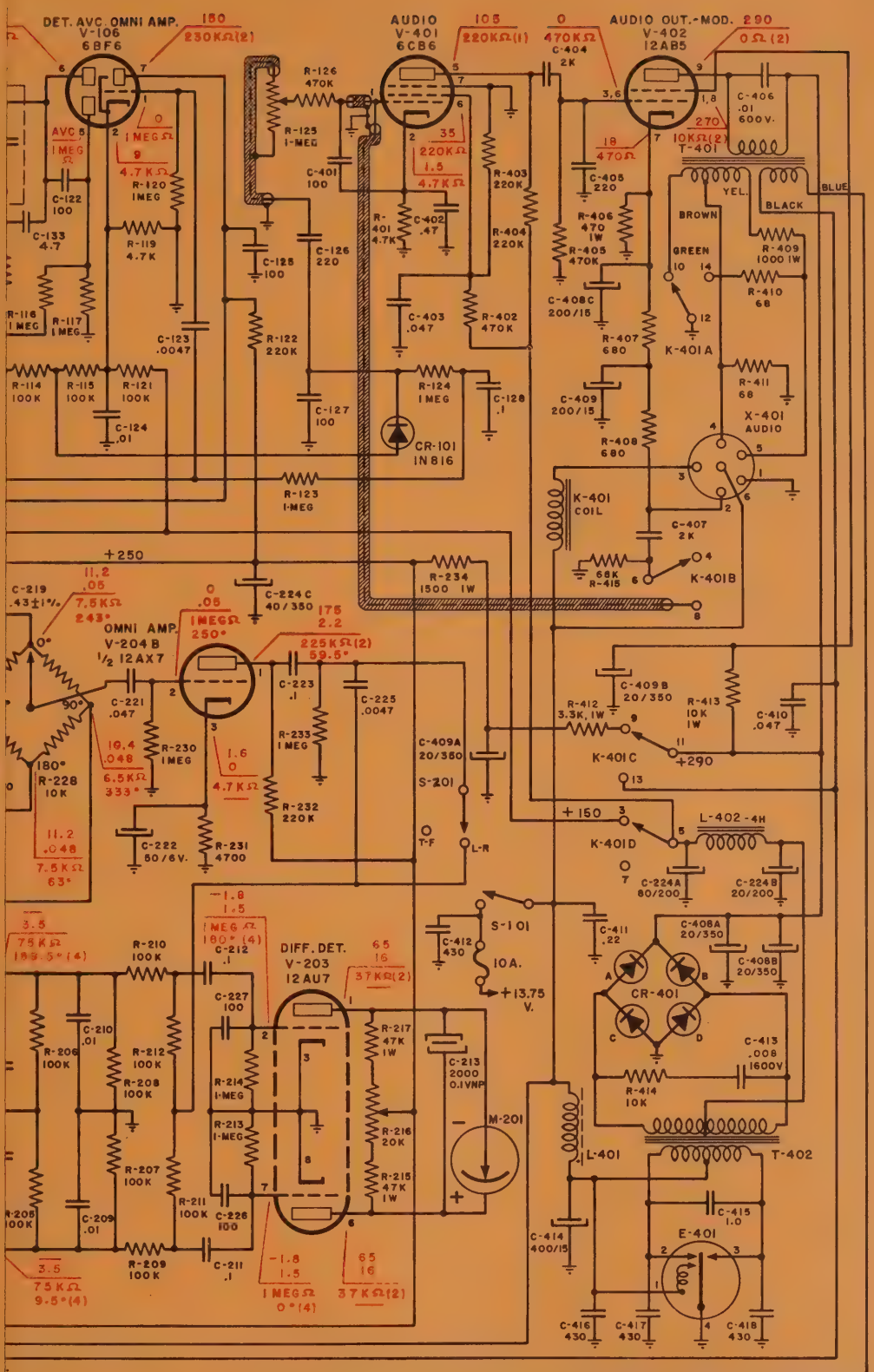
Addition:
R-415 P/N 31141-683. Carbon, ½W., 68K ohms, ±10%.

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

3190-600
Supplement No. 1

Printed in U.S.A.

February, 1966



ALL VOLTAGE, RESISTANCES, AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE OTHERWISE NOTED.
MEASUREMENTS TAKEN UNDER THE FOLLOWING CONDITIONS:

RECEIVER AND AUDIO

A+ INPUT OF 13.75 VDC. RF SIGNAL INPUT MODULATED 30% AT 1000 CPS AT A LEVEL OF 500 MICROVOLTS. OUTPUT TO SPEAKER 2 WATTS.

TRANSMITTER

A+ INPUT OF 13.75 VDC. WITH TRANSMITTER KEYED.

OMNI

A+ INPUT OF 13.75 VDC. SIGNAL INPUT FROM OMNI SIMULATOR AT A 500 MICROVOLT LEVEL. COURSE SELECTOR DIAL SET TO A COURSE OF 0°.

THE FOLLOWING SYMBOLS ARE USED FOR VOLTAGE, RESISTANCE AND PHASE ANGLE READINGS:

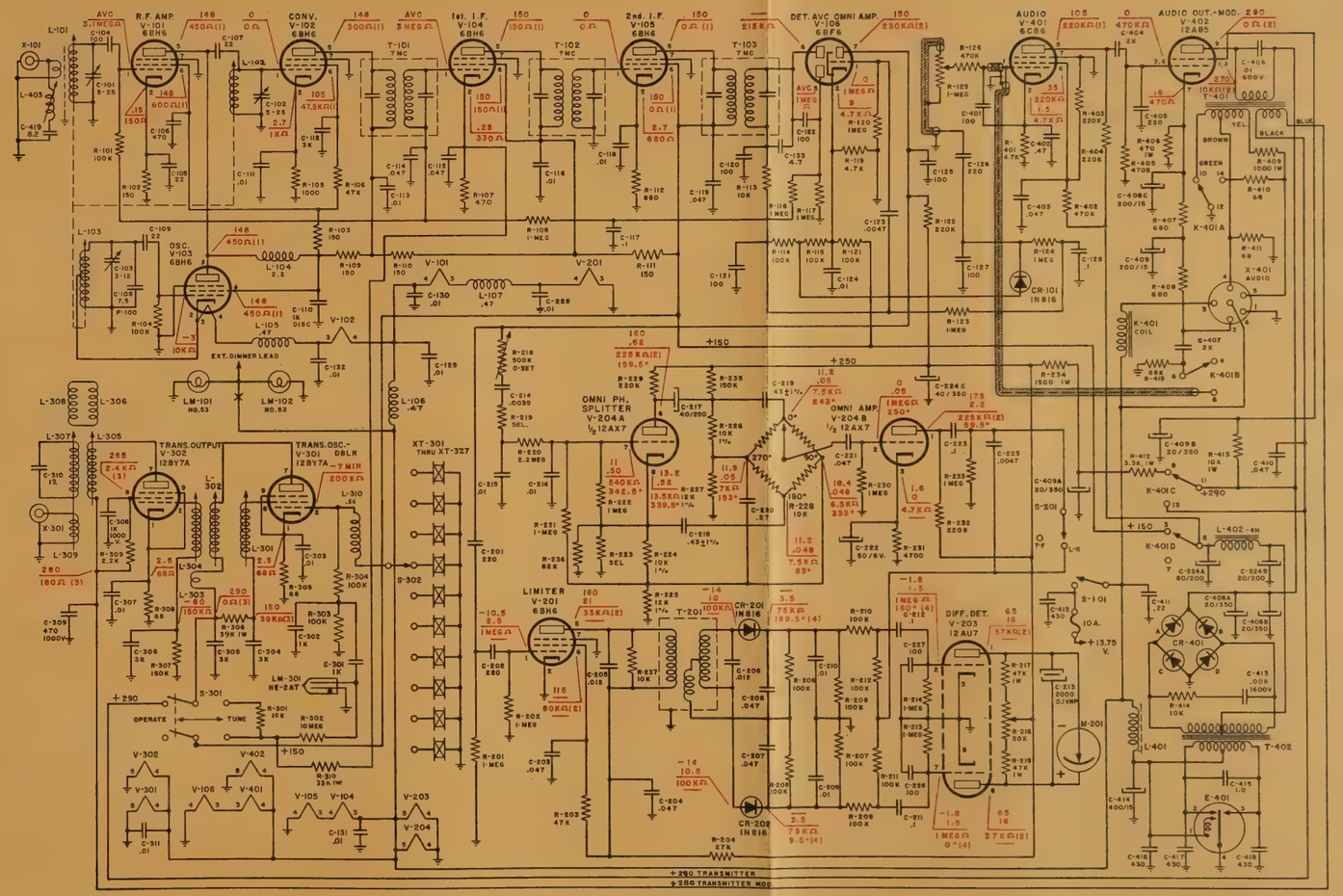
DC VOLTAGE / RESISTANCE — RECEIVER, AUDIO AND TRANSMITTER

DC VOLTAGE / AC VOLTAGE / RESISTANCE / PHASE ANGLE — OMNI

NOTES:

1. MEASURED TO TERMINAL 5 OF K-401
2. MEASURED TO TERMINAL 11 OF K-401
3. MEASURED TO TERMINAL 13 OF K-401
4. MEASURED WITH V-204 REMOVED FROM IT'S SOCKET.

Figure 15A
SCHEMATIC, NARCO SUPERHOMER MK-IV
CN83-A



ALL VOLTAGE, RESISTANCES, AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE OTHERWISE NOTED.
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A+ INPUT OF 13.75 VDC. RF SIGNAL INPUT MODULATED 30% AT 1000 CPS AT A LEVEL OF 500 MICROVOLTS. OUTPUT TO SPEAKER 2 WATTS.

TRANSMITTER

A+ INPUT OF 13.75 VDC. WITH TRANSMITTER KEYED.

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A+ INPUT OF 13.75 VDC. SIGNAL INPUT FROM OMNI SIMULATOR AT A 500 MICROVOLT LEVEL. COURSE SELECTOR DIAL SET TO A COURSE OF 0°.

THE FOLLOWING SYMBOLS ARE USED FOR VOLTAGE, RESISTANCE AND PHASE ANGLE READINGS:

DC VOLTAGE / RESISTANCE — RECEIVER, AUDIO AND TRANSMITTER

DC VOLTAGE
AC VOLTAGE
RESISTANCE
PHASE ANGLE
— OMNI

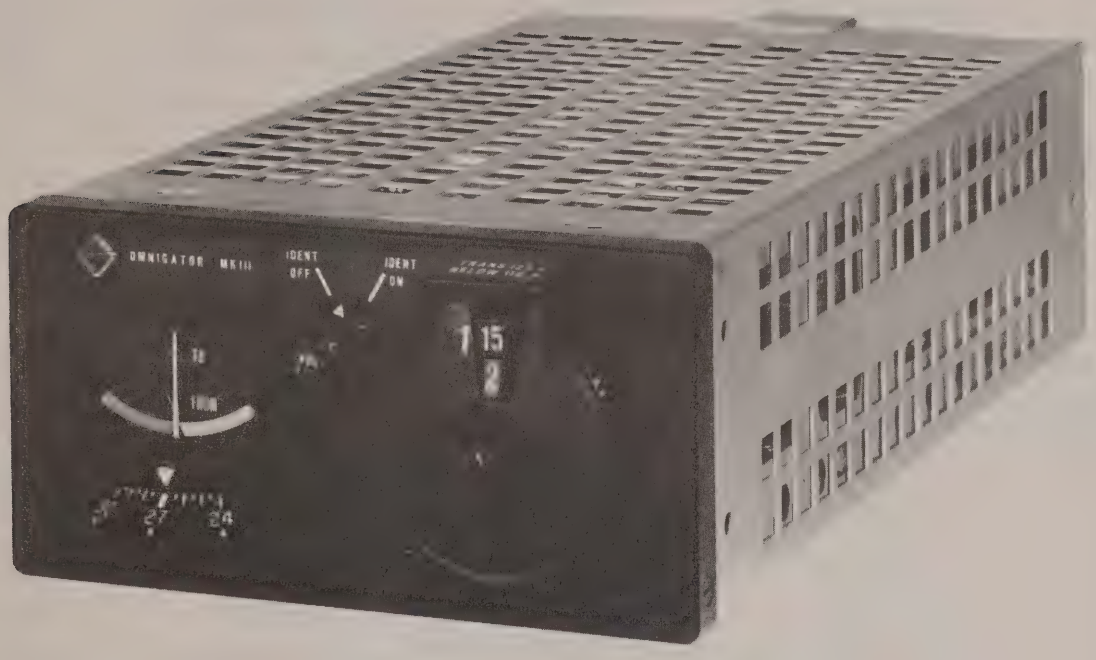
K-401

NOTES:
1. MEASURED TO TERMINAL 5 OF K-401
2. MEASURED TO TERMINAL 11 OF K-401
3. MEASURED TO TERMINAL 13 OF K-401
4. MEASURED WITH V-204 REMOVED FROM IT'S SOCKET.

Figure 15A
SCHEMATIC, NARCO SUPERHOMER MK-IV
CN83-A

inter-city
mfg.
ST. LOUIS, MO.

NARCO OMNIGATOR MARK III



MAINTENANCE MANUAL

for

CN-138-A

Mark III Equipment
for
VHF Communication
and
OMNI Navigation

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

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SECTION 1
GENERAL INFORMATION

1-A. INTRODUCTION.

The *narco* Mark III Equipment is essentially a single unit airborne VHF radio navigation and communication equipment. Both the transmitter and receiver are crystal controlled. The unit is intended for instrument panel mounting and direct manual operation by the pilot. It is designed to operate from a nominal 14 volt D.C. aircraft electrical supply. It normally requires separate antennas for transmission and reception. It requires the usual external microphone with transmit control and either headphones or a loudspeaker. Both phones and speaker may be employed if desired.

The direct manual channel selector controls provide for positive detent selection of 190 channels. Of these, 100 are navigation reception channels and 90 are "simplex" communication channels. The navigation signals operate the indicator on the front panel of the unit and provide voice and identification (IDENT) signals to the audio circuits. The OMNI course selector is a convenient thumb wheel directly below the indicator. The LOCALIZER function is automatically activated when a localizer channel is selected. "Sidetone" is provided to the headphone circuit during transmission.

As a special feature transmission on 122.1 Mc/s is available automatically, whenever the channel selector is set to any one of the 100 navigation channels. This permits communication with Flight Service Stations, by listening on the associated navigation facility. Navigation service is, therefore, disrupted only briefly during transmission and no channel selector switching is involved.

When IDENT has been established the IDENT tone signal may be subdued by means of a front panel switch, associated with the usual power ON-OFF Switch and Volume Control.

1-B. SPECIFICATIONS.

Size:

See Figure 2, Page 28.

Weight:

With Case, 7.5 pounds.

Power Required:

Receive; 13.75 volts, 6.5 amps.
Transmit 13.75 volts, 9.0 amps.

Functions Available:

VOLUME CONTROL, with power ON-OFF switch and associated IDENT ON-OFF.

CHANNEL SELECTOR, with automatic OMNI or LOCALIZER function on appropriate channels.

COURSE SELECTOR and INDICATOR for OMNI and LOCALIZER Left-Right, To-From and Flag Alarm.

Tuning Ranges:

Receiver; 190 channels, 0.1 Mc/s spacing. Range,108.0 thru 126.9 Mc/s.

Transmitter; 90 channels, 0.1 Mc/s spacing. Range 118.0 thru 126.9 Mc/s and also 122.1 Mc/s is automatically available on any navigation channel 108.0 thru 117.9 Mc/s.

RECEIVER:

Sensitivity; 1.0 microvolt for 6db signal + noise, to noise ratio.

Selectivity, overall;
6 db (nose), 42 kc/s minimum bandwidth.
60 db (skirt), 200 kc/s maximum bandwidth.

Image Rejection;
At least 60 db.

AVC;
4 db from 10 to 10,000 microvolts.

Audio Output;
3 Watts.

Omni Accuracy:
±3° nominal.

TRANSMITTER:

Modulation;
Minimum 70%, before clipping 85%.

Duty Cycle;
Maximum 20%.

Power Output;
3 watts nominal.

1-C. LICENSE REQUIREMENTS.

The Federal Communications Commission requires that the operator of the transmitter in this equipment hold a Restricted Radio-Telephone Operator Permit, or higher class license. This permit may be obtained by any U. S. citizen from the nearest field office of the F.C.C.; no examination is required.

The transmitter itself, as installed in the aircraft, requires a Private Aircraft Radio Station License. This license is obtained by filing F. C. C. Form 404.

Since this equipment has been type-accepted by the FCC and entered on their list of type-accepted equipment as "***narco*** Mark III' it must be identified as "***narco*** Mark III" on your FCC Form 404 Station License Application.

CAUTION: The VHF transmitter in this equipment is guaranteed to meet Federal Communications Commission approval only when NARCO crystals are used.

When ordering crystals for additional channels or replacements, state NARCO model number to insure getting properly correlated crystals.

Use of other than NARCO crystals will void manufacturers warranty.

SECTION 2
INSTALLATION

2-A. INTRODUCTION.

The ***narco*** Mark III Equipment consists essentially of a single unit with front panel controls for direct manual operation by the pilot. It is normally installed in or near the instrument panel, for operating convenience.

Installation usually involves primarily the permanent mounting of the case. Installation and removal of the unit proper is then accomplished by operating the latch at the front and connecting or disconnecting the cables at the rear.

To complete the installation the following items are required, if they are not already available. Two antennas (receive and transmit), headphones or loudspeaker or both, and a microphone. For details see the succeeding paragraphs in this section and the diagrams in Section 6.

2-B. UNITS & ACCESSORIES SUPPLIED.

1. ***narco*** Mark III PANEL UNIT with case.
2. CABLE Assembly, 36" long, for Power, Audio and Dimmer circuits, ***narco*** No. 90632-101.
3. Plug for Receiver Antenna, ***narco*** No. 41237-1.
4. FERRULE, for Plug (Item 3, above), ***narco*** No. 41237-2
5. PLUG, for transmitter antenna, ***narco*** No. 41130-2

2-C. ACCESSORIES REQUIRED, but Not Supplied.

1. ANTENNA and Coaxial R. F. Cable for Receiver. A horizontally polarized dipole is required for Navigation Signals. See Items under 2-G., below.
2. ANTENNA and Coaxial R. F. Cable for Transmitter. A vertically polarized unipole over a suitable ground plane is recommended. See items under 2-G., below.
3. HEADPHONES or LOUDSPEAKER, or both if desired. Headphones, Z=300 to 1000 ohms. Loudspeaker, Z=3 to 6 ohms.
4. MICROPHONE. Low impedance type. A noise cancelling type is recommended.
5. FUSE or other D. C. Power Circuit protection rated at 15 amps.

2-D. OPTIONAL ACCESSORIES.

1. ANTENNA for Receiver.
   narco VRP-15A Pedestal Mounting Type, with 100 inch R. F. Cable ***narco*** Item No. El-2056.
2. ANTENNA for Receiver.
   narco VRP-37 Tail Mounting Type, with 30 foot R. F. Cable and "Balun." ***narco*** Item No. EL-2060.
3. ANTENNA for Transmitter.
   narco VTP-17 Bent Rod Type, with 100 inch R. F. Cable ***narco*** Item No. EL-2057.
4. ANTENNA for Transmitter.
   narco VP-10 Broad Band Type, with Gasket, Hardware and BNC R. F. Cable Connector, but without R. F. Cable. ***narco*** Item No. EL-2028.
5. KIT, COOLING, ***narco*** Item No. EL-2096

2-E. MECHANICAL INSTALLATION.

The ***narco*** Mark III equipment is essentially a single unit apparatus in a rectangular metal case. It is intended for Instrument Panel mounting, in a position convenient for direct manual operation by the pilot.

The case is open at the front and rear, except for a vertical ground support strap at the rear. Bosses to accomodate mounting backets are provided at the top, bottom and sides near the front and at the sides near the rear. See Figure 2, Page 28.

The case is normally installed permanently in the aircraft. It is to be fastened by brackets at the front and the ground support stud at the rear. If it is to be mounted in the instrument panel, it may be installed from the front or the rear. It is recommended that it be installed from the rear if possible. This is because, when it is installed from the front it is necessary to make a slightly larger cutout to accomodate the mounting bosses. When this is done the Front Trim Panel will not properly cover the cutout.

Mounting brackets are not supplied because the requirements vary considerably among the various installations. Brackets can be readily fabricated from metal sheet, or angle stock.

With the case properly installed the Unit can be easily put in place. It is done by passing the short cable with a connector thru the case and then, when the unit is properly positioned, fastening it with the screwdriver operated latch. The latch is accessible thru a hole near the bottom center of the front trim panel. The access hole is covered with a snap-in button.

When the ***narco*** Mark III Equipment is to be mounted in a "stack" with other radio equipment, added cooling is of utmost importance for extended reliability. Cooling is desirable for single radio installations as well. An air inlet is located at the rear, near the lower center of the unit. A ***narco*** accessory Kit (EL-2096) may be used to provide the necessary cooling.

2-F. ELECTRICAL CONNECTIONS.

All electrical connections are made to the rear of the Panel Unit Chassis. There are separate connectors for the receiver and transmitter antennas. The case is provided with a ground and support stud near the top of the vertical strap at the rear of the case. The strap also has a grounding jack near the center, which mates with a plug on the chassis. A good electrical connection must be made between the ground and support stud and the metal frame of the aircraft. The remaining connections are made via an eleven circuit connector, P-401, at the end of a short cable extending from the rear of the chassis. This connector mates with J-401 on the Cable Assembly, No. 90632-101, supplied with the equipment. See Figure 1, and Table A, page 27.

2-F,1. Primary Power.

A wire, RED No. 16, about 10″ long extends directly from the connector J-401. It should be connected to the aircraft 14 volt D. C. supply via suitable protection. See Item 2-C,5., above.

2-F,2. Dimmer Circuit.

A wire, WHITE No. 22, about 10″ long extends directly from the connector J-401. It connects with the front panel lamps in the unit and may be connected to a common instrument-panel lamp-dimmer circuit.

If no external connection is made the wire may be connected to terminal No. 2 in J-401. This provides + 14 volts D. C. to the panel lamps, via the ON-OFF switch associated with the volume control on the Front Panel.

2-F,3. Power and Audio Cable Circuits.

A five wire cable, 36″ long extends from J-401, along with the RED and WHITE wires noted under 2-F,1., and 2-F,2., above.

The BLUE, WHITE, BROWN and BLACK wires are properly connected to the two jacks provided on the Cable Assembly supplied with the equipment. The two jacks, for headphones and microphone, are normally mounted on the instrument panel at a place convenient for the pilot. See Table A, page 27.

The GREEN wire for the loud-speaker is unterminated. It may be extended if necessary, to reach the speaker.

2-G. ANTENNAS.

2-G,1. Antenna for Receiver.

The full range and accuracy of the VHF omni-range system can be realized only when the airplane is equipped with the proper type of antenna. **For omni-range reception, a horizontal "V" dipole antenna is absolutely necessary. A vertical whip is definitely not satisfactory,** although it may appear to be when tried. Vertically polarized components are not radiated by the ground stations, but are produced by reflections from trees and similar objects. Therefore a vertical antenna may receive strong signals, but they are reflections and do not come directly from the ground station, giving rise to very unreliable bearings.

The ***narco*** Type VRP-15A horizontal "V" dipole antenna when used should be carefully installed preferably on top of the airplane behind the cockpit, and well away from the engine and propeller. An alternate type of antenna, ***narco*** Type VRP-37, is available for mounting on the upper part of the vertical stabilizer. The nose of the "V" dipole should face directly forward or aft, and the rods should be horizontal in level flight attitude.

The mast of the type VRP-15A antenna contains a matching "BALUN" which serves as an impedance transformer and as a means to connect a coaxial line to the balanced "V" dipole antenna. The type VRP-37 antenna is available with an external "BALUN" which attaches to the antenna rods. The other end of the "BALUN" is factory connected to the coaxial R. F. Cable which connects to the equipment. Either "BALUN" is made of coaxial R. F. Cable cut to critical dimensions which should not be altered. The sheath of the coaxial line to the receiver should be connected to the sheath of the "BALUN" cable and grounded directly to the metal surface of the aircraft. The VRP-15A mast includes this connection in it base. The VRP -37 Cable assembly is provided with a grounding lug for making this connection.

A "T" connector kit, ***narco*** Type VRP-39, is available for dual receiver installations. A small loss in receiver sensitivity may be experienced, when two receivers are operated from the same antenna.

2-G,2. Antenna for Transmitter.

The vertical rod type transmitting antenna, such as the ***narco*** VTP-17, should be mounted on a metal surface measuring at least 18 inches square to serve as a ground plane. Such a mounting surface is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface is available a piece of thin aluminum may sometimes be affiixed flush with the fabric. This thin aluminum sheet or foil may be made to conform to the various curved surfaces to which it is mounted, but all cuts and seams should be along lines radiating from the antenna base. A ½ inch hole should be made in the center of this sheet for mounting the antenna. It is recommended that where necessary a metal reinforcing plate be provided to resist the bending load imposed by the slip-stream. The ***narco*** VTP-17 antenna should not be lengthened or shortened. It has been cut to the proper length for the most efficient radiation at the frequencies generated by the transmitter.

2-G,3. Antenna Cables.

The type VTP-17 transmitting antenna and the type VRP-15A receiving antenna are both available with 100 inch lengths of 52 ohm coaxial transmission line, type RG-58A/U. The alternate type of receiving antenna, type VRP-37, is available with 30 feet of RG-58A/U, 52 ohm coaxial transmission line with an attached "BALUN."

Extra long cables can be obtained on special order from the factory, complete with end fittings, or can be assembled in the field.

Note that the VRP-15A receiver antenna cable has a phono-type connector on the antenna end (VRP-37 has two lug terminals) and an auto-type connector on the set end. The VTP-17 transmitter antenna cable has a phono type connector on the set end and lug and clamp fittings on the antenna end. Thus the cables are not directly interchangeable at either end.

2-H. INSTALLATION CHECK.

2-H,1. Ignition Shielding.

It is possible in some types of airplanes to get satisfactory reception without special precautions. However, it is always advisable and frequently absolutely necessary to provide properly fitted ignition shielding. It has been found that such shielding when not in first class condition as to clean and tight joints, etc., can cause a lot of noise, particularly at VHF. It is therefore, recommended that any ignition shielding in the airplane in which the equipment is being installed by thoroughly inspected, and overhauled if necessary, at the time of installation.

2-H,2. Operating Tests.

After the installation has been completed, it should be operated on the ground, with all normal power turned on and the engine running. The receiver should be checked for proper operation by channelling to available signals. The transmitter output and audio quality maybe checked by contacting a Control Tower. The OMNI performance may be observed by tuning to one of the VOR check points (VOT), listed in the Airmans Information Manual.

SECTION 3
OPERATION

3-A. INTRODUCTION.

Operation of the ***narco*** Mark III Equipment as described in this Manual is primarily, functional for the purpose of providing proper maintenance. Details of navigation and piloting are left to the Operators Manual.

3-B. CONTROLS & INDICATOR.

3-B,1. On-Off/Volume and Ident.

The small knob near the top center of the front panel operates the power ON-OFF switch and the receiver VOLUME CONTROL. The switch, S-401, is directly in the +14V., d.c. line and is "OFF" in the maximum counterclockwise position. The volume control, R-129, is in the output circuit of the detector CR-104. It operates on all navigation and communication channels. Volume increases with clockwise rotation.

The larger concentric knob near the top center operates the IDENT filter switch, S-102. In the IDENT OFF position (CCW) the switch is open and the filter is in the circuit, to remove the 1020 c/s tone signal.

3-B,2. Channel Selector.

The Channel Selector at the right of the front panel consists of a large outer knob to select the whole Megacycle (Mc/s) frequencies and a smaller concentric knob to select the Fractional Mc/s Channels. Both knobs operate crystal selector switches and step inductors, in a complex manner, as described in Section 4, Page 15 and diagrammed in the circuit schematic, Figure 7, Page 51.

The Channel Selector provides positive detent switching for all Navigation and Communication channels. Operation of both knobs is continuous, in either direction, without stops. In the Navigation range of 108.0 thru 117.9 Mc. the transmitter is always tuned to 122.1 Mc/s the common air-to-ground Flight Service Station (FSS) frequency.

In the Communications range of 118.0 thru 126.9 Mc/s the receiver and transmitter are always tuned to the same frequency, to provide "SIMPLEX" operation.

3-B,3. Indicator and Course Selector.

The Indicator meter, I-201, at the upper left of the front panel operates on all navigation channels, VOR and ILS LOCALIZER, 108.0 thru 117.9 Mc/s. When the Channel Selector at the right of the panel is set to an ILS LOCALIZER channel (odd tenths Mc/s 108.1 thru 111.9 Mc/s) the Indicator shows left or right deviation from the selected Glide-Path. When a VOR Channel is selected (even tenths 108.0 thru 111.8 Mc/s and all channels 112.0 thru 117.9 Mc/s) the Indicator shows left or right deviation from the course chosen on the Course Selector Dial below it.

The Indicator also provides TO-FROM and weak signal information in the form of white triangles near the center of the instrument. The indication is the magnetic bearing TO or FROM the selected VOR station, when the Indicator needle is centered, regardless of the heading of the aircraft in which the equipment is installed. If the TO or FROM triangle is not completely filled by the white flag, the signal is weak and the course indication may not be reliable.

The Course Selector Dial, R-252, is a horizontal thumbwheel at the left of the front panel, below the Indicator. Operation is continuous, in either direction, without stops. The Course Selector Dial operates whenever the channel selector is set to a VOR Channel (even tenths 108.0 thru 111.8 Mc/s and all channels 112.0 thru 117.9 Mc/s)

The Course Selector Dial is in-operative on the ILS LOCALIZER Channels. Its setting does not affect ILS LOCALIZER operation.

3-C. OPERATING PROCEDURES.

Detailed information concerning operating procedures is provided in the Operating Instructions, OM-220, which is shipped with each Equipment.

Much information on operating practices is provided in the current issue of the FAA "Airmans Information Manual" (AIM). Also, the various Local, Sectional, WAC and Radio Facility Charts provide much useful and practical information.

SECTION 4
CIRCUIT DESCRIPTION

4-A. INTRODUCTION.

The *narco* Mark III Equipmet provides in a single unit a 90 channel Communications Transceiver and a 100 channel Navigation Receiver. All communication and navigation receiver and transmitter channels are crystal controlled. The Channel Selector provides positive detent step tuning for all 190 channels, 108.0 thru 126.9 megacycles (Mc/s). In the communications range of 118.0 thru 126.9 Mc/s the transmitter and receiver are always tuned to the same frequency, for SIMPLEX operation. On all navigation channels 108.0 thru 117.9 Mc/s special circuit switching is provided so that the transmitter is always on the enroute frequency of 122.1 Mc/s A separate crystal is provided for this purpose. Also, when a navigation frequency is selected, the INDICATOR, M-201, is automatically switched to the VOR or ILS LOCALIZER circuits, depending on the channel selected. Twenty channels, odd tenths Mc/s 108.1 thru 111.9 are ILS LOCALIZER channels. The remaining 80 channels are assigned to VOR service.

4-A,1. Receiver.

The receiver is a double conversion superhetrodyne type having a first IF in the vicinity of 17 Mc/s for the navigation frequency range and a first IF in the vicinity of 9 Mc/s for the Communications range. The second IF is fixed at 4.0 Mc. on all channels.

4-A,2. Transmitter.

The transmitter employs a balanced mixer for all 90 SIMPLEX communications channels. A separate crystal, XT-316, is used to double directly to the 122.1 Mc/s enroute frequency, which is always available on the receiver navigation frequencies.

4-A,3. Omni and Localizer.

The OMNI and LOCALIZER converter circuits operate from the receiver section detector, CR-103, output. Visual information is displayed on the INDICATOR. Aural identification may be controlled by the IDENT ON-OFF Switch.

Details of the various circuits are given in succeeding paragraphs in this section, in the Block Diagram, Figure 3, page 31 and in the Schematic Diagram, Figure 7, page 51.

4-B. CIRCUIT ARRANGEMENT.

The transmitter, receiver and navigation sections employ fairly conventional circuits except for the crystal frequency control arrangement. The High Frequency Oscillator (HFO), Doubler, Mixer and Amplifier circuits for the receiver and transmitter are separate However, the Low Frequency Oscillator (LFO) is common to both the transmitter and receiver.

The crystal utilization is unique and economical. The complex switching is such that a single set of 15 crystals (XT-301 thru XT-315) provide a total of 190 receiver and 90 transmitter channels, all completely crystal controlled. This is accomplished by operating crystals of the overtone type on both their fundamental and 5th overtone modes. The fundamental frequencies in the range of approximately 13.5 to 12.6 Megacycles (Mc/s) are used by the COMMON LFO to provide the low mixer injection frequencies for both the transmitter and the receiver. The fifth overtone frequencies in the range of approximately 62.7 to 69.7 Mc/s are used by the separate receiver HFO to provide the high mixer injection frequencies.

On some channels a given crystal may be functioning on both its fundamental frequency and the 5th overtone at the same time. The overtone frequency is normally not an exact multiple of the fundamental frequency. For details of the crystal frequency arrangement see the Tables I and II, on Pages 29 and 30.

The 122.1 Mc. transmitter channel used with all of the navigation channels is a conventional oscillator, doubler, amplifier arrangement. It uses a separate crystal XT-316.

4-C. NAVIGATION/COMMUNICATION RECEIVER.

A crystal controlled, double conversion super-heterodyne circuit is employed in the receiver of the Mark III equipment. The desired signal enters the receiver at the antenna connection, J-101. Under certain condtions, there may be spurious responses from near-by FM Broadcasting Stations appearing in the navigation channels. To avoid such spurious responses, a series tuned trap, L-109 and C-147, shunted across the Receiver Antenna Connector, J-101, tuned to 98 Mc/s has been incorporated. Two separate oscillators are used in the receiver, both using a common set of crystals.

4-C,1. High Frequency Oscillator (HFO).

The high frequency oscillator, V-2B, is a crystal stabilized modified Colpitts oscillator using the triode section of a 6KE8 tube. The frequency range, using the fifth overtone of the crystals is approximately 62.7 Mc/s to 67.7 Mc/s in 0.5 Mc/s steps. The HFO energy is injected through C-109 into the control grid of the first mixer V-2A, where it doubled and mixed with the incoming RF signal from the RF amplifier, V-1A. The difference frequency between the incoming RF signal and 2 times the HFO is the High Frequency IF (first IF).

On Navigation Channels, the HF IF is from approximately 17.5 to 16.6 Mc/s. The transformer T-101 is switched into the plate circuit of V-2A and tracks over this frequency range. On Communication Channels, the HF IF is from approximately 9.5 to 8.6 Mc/s. The transformer T-102 is switched into the plate circuit of V-2A and tracks over this range. The output of the HF IF is applied to the control grid of the second mixer V-9B.

4-C,2. Low Frequency Oscillator (LFO).

The low frequency oscillator, V-3B, is a crystal stabilized, modified Colpitts oscillator operating on the fundamental frequency of the crystals, approx. 13.5 to 12.6 Mc/s in tenths Mc/s steps. The ouput of the oscillator is inductively coupled into the cathode of the second mixer V-9B through L-329. The low frequency (4.0 Mc. fixed) IF (second IF) is produced by selecting the difference frequency between the high frequency IF output and the LFO injection frequency. This selection is done by T-103, which is the first of three 4.0 Mc/s IF transformers. The signal from T-103 is applied to the control grid of V-4A. It is amplified by V-4A, applied through T-104 to V-10A where it is again amplified. It is then applied through T-105 to CR-103, which is a silicon diode detector.

NOTE: This receiver LFO is common with the transmiter LFO, as outlined under 4-B., above.

4-C,3. IDENT Filter.

The output of the detector is fed into an IDENT Tone Filter Network, consisting of C-145, L-401, and R-128. This filter is switched in and out of the circuit by S-102, which is the outside knob on the volume control ON-OFF Switch assembly on the front panel. This filter is used on the navigation frequencies to eliminate the 1020 cycle IDENT tone used for identification of OMNI Stations. When the switch on the front panel of the unit (S102) is placed in the "IDENT-OFF" position, the IDENT tone on the OMNI Station being received is greatly reduced and any voice transmission on the channel may be clearly heard. Placing the switch in the "IDENT-ON" position allows the tone identification to be heard, to identify the OMNI Station being received. The output of the IDENT Filter is passed through a peak limiting noise limiter, CR-104, to the input of the audio volume control, R-129. The output of the volume control is applied through C-405 to the control grid of V-6A, the first audio amplifier.

4-C,4. Automatic Volume Control (AVC).

AVC voltage is developed by detector current through R-124 in the CR-103 detector output circuit. AVC voltage is applied to the RF and IF stages with the exception of the first mixer, V-2A, and the last IF amplifier, V-10A. On navigation channels (108.0 - 117.9 Mc/s) S-301-A adds C-121 (0.22uf) to increase the time constant.

4-C,5. Audio Circuits.

The plate circuit of the first audio amplifier V-6A is resistance coupled to the grid of the audio output stage, V-7. The plate of the audio output stage is connected to an output transformer, T-403, which has a low-impedance winding tapped to match a three to six ohm speaker voice coil and one or two pairs of 600 ohm headphones. This transformer also includes a high-impendance winding for modulating the VHF transmitter. Switching is provided so that a "sidetone" signal is available in the headphone circuit while transmitting.

4-D. COMMUNICATIONS TRANSMITTER.

There are 90 crystal-controlled transmitter channels provided by the Mark III Equipment. The transmitter is of the heterodyne type. Two separate oscillators are used, both using a common set of crystals. The Low Frequency Oscillator (LFO) uses the fundamental frequency of the crystals, approx. 13.5 to 12.6 Mc/s The High Frequency Oscillator (HFO) uses the fifth overtone of the crystals, approx. 65.7 to 69.7 Mc/s. The HFO output is doubled into a balanced transistor mixer, Q-301 and Q-302. The desired transmitter frequency equals 2 times HFO minus LFO, except when a navigation channel is selected. Additional contacts on the transmitter crystal switch and step inductors select a special crystal (XT-316) and necessary coils (L-331, L-332, L-333, L-334, L-335) to operate the transmitter on 122.1 Mc/s. The LFO is not used in transmit over the range of 108.0 to 117.9 Mc/s (refer to Schematic Diagram, Figure 7, Switch S-301). The transmitter will operate only on 122.1 Mc/s during receiver operation in the 108.0 to 117.9 Mc/s range. Switching to the communications channels will again place the transmitter in its "SIMPLEX" mode of operation.

4-D,1. High Frequency Oscillator (HFO).

This is a crystal stabilized, modified Colpitts oscillator using the triode section of a 6GH8A (V-6B) tube. The feedback is through the fifth overtone series resonance of the crystals. Energy is capacity coupled from the tank circuit to the grid of the HF Doubler (V-1B).

4-D,2. High Frequency (HF) Doubler.

The output frequency of the HFO is doubled by V-1B and supplied to the Balanced Mixer, Q-301 and Q-302, via the junction between C-345 and C-346.

4-D,3. Low Frequency Oscillator (LFO).

This is a crystal stabilized, modified Colpitts oscillator using the triode section of a 6GH8A (V-3B) tube. The feedback is through the fundamental series resonance of the crystals. Energy is inductively coupled to a balanced transistor mixer. Ten crystals are used in the range of approximately 13.5 to 12.6 Mc/s.

NOTE: This transmitter LFO is common to the receiver LFO, as outlined under 4-B., above.

4-D,4. Balanced Mixer.

The Balanced Mixer employs the two transistors Q-301 and Q-302 in a symmetrical circuit to mix signals from the HFO, via the HF Doubler, and the LFO to produce the desired transmitter output frequency. This frequency is the difference between 2 times the HFO and the LFO. The output of the Balanced Mixer is inductively coupled via L-330 to the grid of the Buffer tube V-5B.

4-D,5. Buffer.

The buffer stage, V-5B, which operates at the transmitter output frequency, serves to raise the signal level from the Balanced Mixer and isolate the latter from the driver stage, V-11.

4-D,6. Driver.

The driver stage, V-11 raises the level of the buffer output V-5B to give proper drive to the final transmitter output amplifier, V-12.

4-D,7. Final Amplifier.

The final amplifier, V-12, is a 7701 beam power amplifier. It delivers approximately 3 watts of RF carrier power to the output circuits.

4-D,8. Modulator.

High level plate modulation is applied to the final amplifier by V-7, the 12AB5 modulator tube. Speech signals from the microphone are applied to the control grid of V-6A, which amplifies the signal and applies it to the grid of V-7. Speech limiting (to prevent overmodulation) is provided by driving the modulator tube (V-7) into saturation.

4-E. OMNI CIRCUITS.

4-E,1. Omni Signal.

The received signal is a VHF carrier, amplitude modulated with the following:

a. Voice modulation, 200 to 2500 c/s (35% maximum modulation).
b. Reference phase signal (30% modulation) 9960 cycles subcarrier, frequency modulated between 9480 and 10,440 cycles with a fixed phase 30 c/s modulation.
c. Variable phase signal (30% modulation) 30 c/s produced by rotating effectively a limacon antenna pattern 30 times per second.

4-E,2. Reference Phase Channel.

This channel consists of two stages, V-3A and V-10B. The detected signal is injected into V-3A through a two section high pass filter. This stage, V-3A, is operating as a limiter and drives an FM discriminator involving T-202, CR-201 and CR-202. The detected 30-cycle signal is injected into the reference channel output amplifier (V-10B) through a low pass filter. The cathode voltage from V-10B is coupled into the L-R phase demodulator circuit for comparison with the variable phase signal. The plate voltage of V-10B is transformer coupled via T-203 into the T-F phase demodulator involving CR-204 and CR-206. This signal is rotated in phase 90 degrees by the transformer T-203 and the capacitor C-240.

4-E,3. Variable Phase Channel.

This channel consists of three stages, V-8A, V-9A, and V-4B. The first stage, V-8A, is a phase splitter whose outputs are coupled into the course selector, R-252. The output from this course selector is continuously variable through 360 degrees. This signal is amplified through the two stage, selective frequency, feedback amplifier consisting of V-9A and V-4B. The phase of the output signal can be shifted ±10 degrees by adjusting the zero set potentiometer, R-214, in the feedback circuit to the grid of V-9A. The output from the amplifier (V-9A and V-4B) is transformer coupled via T-201 to the balanced phase demodulator involving CR-203 and CR-205.

4-E,4. Phase Demodulator (Metering Circuits)

The L-R circuit consisting of CR-203, CR-205, R-248, and R-247 will cause the zero center INDICATOR, M-201-A, to have zero deflection when the variable phase output signal and the reference phase output signal are 90 degrees out of phase.

The T-F circuit consisting of CR-204, CR-206, R-249, and R-250 will cause the T-F INDICATOR, M-201-B, to read full "TO" or "FROM" when the reference channel output is "in-phase" with one of the vector components from the center tapped, variable channel output transformer, T-201.

4-E,5. Localizer Circuit.

The detected 90/150 cycle signal from the receiver section detector, CR-103, is amplified by V-8B, the localizer amplifier. The output of V-8B coupled to the feedback amplifier consisting of V-9A and V-4B, through a notch filter tuned to approximately 115 cycles. The notch filter will shift the phase of the 150 cycle signal approximately +45 degrees and the 90 cycles signal –45 degrees. The detected localizer signal is also amplified without phase shifting through V-10B. The two signals, i.e., the phase shifted signal and the unshifted phase signal, are then compared in the phase demodulator circuits. The meter can be zeroed by adjusting R-226 which will shift the phase of the 90 and 150 cycle signals. A change in the amplitudes of the signals, one increasing the other decreasing, will cause a deflection in the L-R meter. This is caused by the vector resultant of the one signal to increase while the vector resultant of the other signal decreases.

4-F. POWER CIRCUITS.

The power supply section of the Mark III Equipment uses two transistors, Q-401 and Q-402, and a power transformer, T-404. The instant primary voltage is applied (A+), because of the inevitable dissimilarity of the two transistors, more current will flow in one than in the other. This greater flow of current through one-half of the primary winding of the power transformer induces a bias on the transistors such that the conducting unit is driven into greater conduction and the other is held at cut-off. Almost instantly the transformer reaches saturation. Thus having reached maximum flux density, there is no more induced voltage in the bias windings which are connected to the transistor circuitry. Therefore, the current through the conducting transistor decreases, and bias voltage at opposite polarity is developed which cuts off this transistor and

simultaneously causes the second transistor to conduct. The above procedure repeats with the second transistor. This switching action repeats at high speed and the resultant output voltage of T-404 is essentially a square wave.

A full wave bridge rectifier consisting of CR-402, CR-403, CR-404, and CR-405 in conjunction with the center tapped secondary of T-404 provides a simple means of obtaining a dual voltage output. Filtering of these DC voltages is easily accomplished because of the high frequency of the power supply.

The operating frequency of the power supply is in the vicinity of 2500 c/s.

SECTION 5
MAINTENANCE, SERVICE PROCEDURES

5-A. INTRODUCTION.

The ***narco*** Mark III Equipment is essentially a single unit equipment. It will usually be found with its case permanently mounted in or near the aircraft instrument panel in a position convenient for direct manual operation by the pilot.

External accessories provided are headphones, or loudspeaker, or both; a microphone, and two separate antennas. For proper VOR operation the receiver requires a horizontal dipole. The transmitter requires a vertical unipole.

Power for operation of the equipment will be from a nominal +14V., d.c. supply.

5-B. MECHANICAL ACCESS.

5-B,1. Unit Access.

To remove the ***narco*** Mark III unit from its case it is necessary to disconnect the two antennas by removing their two connectors from the rear panel and to disconnect the power and accessory connector on a short cable extending from the rear of the unit. The unit is fastened to its case by a latch accessible thru a hole in the Front Panel, near the lower left of the Channel Selector. The hole is normally provided with a snap-in cover. A common flat blade screwdriver is required to operate the latch. After operating the latch, the unit should be free for easy withdrawal.

5-B,2. Component Access.

The design of the Unit on a flat and shallow chassis is such that direct access to a large majority of the components is possible from above or below, as soon as the unit is removed from the case. When access is required to components on the front or rear panels or on the OMNI circuit board along the left side, the following sub-sections should be consulted.

5-B,3. Front Trim Panel Removal.

The front panel may be removed by proceeding as follows:

a. Remove the two small concentric knobs (VOL and IDENT) near the top center of the panel. Each one is fastened with two hex socket head setscrews.
b. Remove the four slotted flat-head black machine screws, two at each side.
c. The panel may now be lifter off, without removing the Channel Selector knobs.

Removal of the front panel provides access to the following items:

I-401, I-402 and I-403, Panel Lamps.
M-201, Indicator mounting screws.
R-252, Course Selector bracket screws.
S-401/R-129 with S-102, the ON-OFF/VOL. with IDENT, Switch Assembly.
L-401 IDENT Filter Adjustment.
Channel Selector Knobs and Shafts.

Procedure for removal and replacement of the above items will be fairly obvious, except for the Channel Selector shafts. These will be covered in later paragraphs

5-B,4. Rear Panel Access.

Access to all components on the rear panel may be had without disconnecting any wires, after removing the eight screws holding the panel to the chassis and tilting the panel away from the chassis. Location and arrangement of the associated spacers and hardware should be noted, to enable proper replacement.

5-B,5. Left Side and OMNI Board Access.

When the Unit is out of its case there is access to certain adjustments and test points on the OMNI circuit board as illustrated in PHOTO E, page 37. Additional test points become accessible when the metal frame side panel is removed. See PHOTO F, page 37.

The left side frame may be removed without removing the front or rear panel. The procedure is as follows:

a. Remove two screws thru the left of the rear panel.
b. Remove two screws to the bracket behind the front panel.
c. Remove two screws to the horizontal chassis, along the lower side of the frame.
d. Remove three flat-head screws along the top of the frame. *Note* that there are three insulating washers between the frame and the OMNI board.

If access to components on the OMNI printed circuit board is required, the board may be detached and laid aside without disconnecting any wires. The lower edge of the board is attached to the chassis via three screws thru metal tabs on the chassis. *Note* that when re-fastening the board, it belongs on the inside of the metal tabs.

5-B,6. Right Side Access.

The right side frame may be removed without removing the front or rear panel. To remove the frame simply remove the two screws to the rear of the front panel and two more screws to the chassis along the lower edge.

Removal of the right side frame permits access to the Channel Selector crystal switching assembly.

5-C. MECHANICAL MAINTENANCE.

All moving parts are associated with the direct manual controls on the Front Panel. They do not normally call for routine maintenance. However, removal and replacement of the Channel Selector Shafts may be required if trouble develops in the Channel Selector Assemblies.

5-C,1. Channel Selector.

The Channel Selector consists of two separate concentric manually operated assemblies. Either assembly may be rotated continuously in either direction, because there are no stops.

a. The Tenths Megacycle (Mc/s) Selector is operated by the small central knob, which is attached to a long ¼" diameter phenolic shaft. This shaft runs thru the hollow Mc/s shaft and operates the crystal selector switch section S-103 combined with L-307, and the combined S-202-A/S-202-B switch sections for the VOR/LOC function. These two sections are located to the rear of the crystal assembly and are driven by flats on the ¼" shaft. The detent machanism is at the rear of the switch sections. See Photo C. Page 35.

b. The Whole Mc/s Selector is operated by the large outer knob. This knob is attached to a hollow ⅜" O.D. phenolic shaft having flats, which drives a total of 13 variable inductor and switch sections and the crystal selector switch S-302. See Photo C, page 35. Its detent mechanism is on the front of the metal front sub-panel. See Photo B, Page 34.

5-C,2. Tenths Megacycle Selector.

In order to remove and replace either of the two switch sections driven by the Tenths Mc/s knob it is necessary to remove the ¼" dia. phenolic shaft. To do this proceed as follows:

a. Set the dial to the 0.0 Tenths Mc/s position.

b. Remove the Front Trim Panel as outlined under 5-B,3 above.

c. Find the tenths Mc/s detent assembly just forward of C-414. See Photo C, Page 35. *Note* the arrangement of the detent assembly.

d. Loosen the two setscrews holding the detent "STAR" wheel, which is part of the detent assembly.

e. Remove the shaft by pulling on the tenths Mc/s knob. The detent assembly will fall free.

To replace the shaft, reverse the above procedure.

5-C,3. Whole Megacycle Selector.

In order to remove and replace any of the variable inductors or switches driven by the whole Mc/s knob, it is necessary to remove the ⅜" O.D. phenolic shaft. To do this proceed as follows:

a. Set the dial to the 108 Mc/s position.

b. Remove the Front Trim Panel as outlined under 5-B,3 above.

c. Loosen the two setscrews holding the Tenths Mc/s knob and remove it. *Note* that the Whole Mc/s shaft can be removed without removing the Tenths Mc/s shaft.

d. Loosen the two setscrews holding the Whole Mc/s knob and remove it.

e. Loosen and remove the two screws and associated hardware which hold the detent assembly to the metal front sub-panel. See Photo B, Page 34.

f. Remove the shaft by pulling on the detent assembly. The detent assembly will remain intact on the shaft.

To replace the shaft, reverse the above procedure. *Note,* however, that the black phenolic retainer rod above the switch and inductor sections must be in position to permit replacing the shaft without difficulty.

5-C,4. Reference Marks and Positions.

All mechanical position references are as viewed looking at the Front Panel in an upright position.

a. Tenths Mc/s Shaft.

When the Selector is in the 0.0 Mc/s position the flats on the rear end of the ¼" shaft are in a plane 18° counterclockwise from the vertical. The shaft should extend beyond the rear of the detent "STAR" bushing by about 1/16".

b. Tenths Mc/s Switch Sections.

The switch section rotors S-301/L-307 and S-202-A/S-202-B have reference notches on one side of the "double D" cutout for the ¼" shaft. These reference notches are on the right hand flat when the selector is in the 0.0 Tenths Mc. position. A further check on the S-103/L-307 section may be made by observing that the rotor contact is on the stator contact at the top left to which a small coax cable is connected, when the Selector is in the 0.0 Tenths Mc. position.

c. Whole Mc/s Shaft.

When the Selector is in the 108 Mc. position the flats on the ⅜" O.D. shaft are in a vertical plane.

d. Whole Mc/s Varible Inductors and Switches.
Each of these inductor and switch section rotors has a reference notch on one side of the "double D" cutout for the ⅜" O.D. shaft. These reference notches are on the right hand flat when the selector is in the 108 Mc/s position.

5-C,5. Whole Mc/s Switch and Inductor Sections.

The first 13 sections driven by the Mc/s Selector knob

are retained by a notched black phenolic rod which must be removed to remove a switch section. To remove this retainer rod proceed as follows:

a. Remove the "D Washer" on the front of the metal front sub-panel, near the panel lamp I-402. See Photo B, Page 34.

b. Remove the two retainer springs at the top of the first and seventh vertical metal shields.

Note that the ⅜" O.D. shaft should be removed before removing the retainer rod and be replaced after the retaine rod is back in position, to avoid difficulty. The removal and replacement of a particular section will depend on its connections. The procedure must be determined by inspection.

5-C,6. Quartz Crystals.

All 16 Quartz frequency control crystals XT-301 thru XT-316 are assembled on a printed circuit board between the two switch sections S-302 and L-307/S-103.

The crystals are of the wire-in type. Removal and replacement must be done carefully. The procedure is to disconnect the lead to S-302, first and then, using printed circuit techniques, disconnect both leads from the printed circuit board. For details concerning printed circuit methods refer to 5-I., page 24.

5-D. ELECTRICAL MAINTENANCE.

5-D,1. Equipment Required.

1. R.F. Power Wattmeter, Bird Termaline Model 61, or equivalent.
2. DC Vacuum Tube Voltmeter (DC VTVM), RCA Senior Voltohmyst, with WG-301A Crystal Diode Probe, or equivalent.
3. AC Vacuum Tube Voltmeter (AC VTVM), Ballantine Model 300, or equivalent.
4. Low Impedance Microphone, with "push-to-talk" button.
5. MF/HF Signal Generator, General Radio Model 1001-A, or equivalent.
6. VHF Signal Generator, Hewlett-Packard Model 608-D, or equivalent.
7. Audio Wattmeter, General Radio Type 583-A, or equivalent.
8. Low Voiltage D.C. Supply, 12-15V., dc at 10 to 15 amperes, Electro Products Laboratories, Model NFB, or equivalent.
9. Omni Signal Generator, Aircraft Radio Corporation, Model H-14A, or equivalent.
10. For phase angle measurement, four additional pieces of equipment are required, as indicated in the Test Setup Diagram, Figure 6, page 33.

5-E. OVERALL OPERATING CHECK.

5-E,1. Receiver.

Procedure:

a. Refer to the "Receiver Test Setup", Figure 4, page 32.

b. Connect the audio output (5 watts full scale), meter to the output cable Pins 4 and 8 on J-401/P-401.

c. Connect the AC VTVM to TL-20, terminal No. 5 (2 VAC full scale). Refer to Schematic Diagram, Figure 7, page 51 (Junction R-124 and C-137).

d. Connect the VHF Signal Generator to the antenna connector J-101. Set the Signal Generator for a 108.0 Mc. thru 126.9 Mc/s range, with 1000 cps, 30% modulation.

Normal Indications:

e. A signal of 3.5 μv maximum should produce a detector output of 1.3V RMS and 1.5 watts minimum (volume control at maximum) on all NAV channels.

f. A signal of 6 μv maximum should produce a detector output of 1.3V RMS and 1.5 watts minimum (volume control at maximum) on all COM channels.

g. A signal of 1.5 μv maximum should produce 6db signal plus noise to noise at the speaker output in all NAV channels.

h. A signal of 2.5 μv maximum should produce 6 db signal-plus-noise to noise at the speaker output on all COM channels.

i. If normal indications are not obtained, refer to the procedures outlined in the paragraphs under 5-F., below.

5-E,2. Transmitter.

Procedure:

1. Refer to the "Transmitter Test Setup", Figure 5, page 32.
2. Connect the R.F. Wattmeter to J-301, the transmitter antenna connector, in place of the antenna.
3. Place the Channel Selector on any COM channel, 118.0 thru 126.9 Mc/s.
4. With the "Push-to-talk" Microphone connected, activate the transmitter.
5. Check all transmitter channels over the complete range of 118.0 thru 126.9 Mc/s.

Normal Indication:

Power output should be a minimum of 2 watts on all channels without modulation. Voice modulation should cause a slight increase in the output power.

If a normal indication is not obtained, refer to the procedures outlined in the paragraphs under 5-G., below.

5-E,3. OMNI and Localizer Circuits.

a. Connect the test equipment to the receiver as shown in Figure 6, page 33.

b. Set the receiver Channel Selector dial to an OMNI channel.

c. Set the R.F. Signal Generator output at 500 microvolts. Set the OMNI course selector at 0° with the modulation switch on the OMNI position.

d. Set the receiver course selector dial to 0°. The Left - Right needle should read center, and a full "TO" flag should show. Rotate the Omni signal generator to 180° and note any Left - Right needle swing. Full "FROM" flag should show.

e. Check course selector heading against OMNI Signal Generator headings. They should agree within ±4°.

f. Set Omni signal generator for localizer signal output. Set the receiver dial for an odd tenth megacycle channel 108.1 thru 111.9 Mc/s.

g. Check centering of left-right needle. A change of 4 db localizer signal will give deflection to the edge of the color sections.

5-F. RECEIVER ADJUSTMENT PROCEDURES.

5-F,1. High Frequency Oscillator (HFO).

Connect the DC VTVM as shown in the Receiver Test Setup, Figure 4., page 32. The drive at Pin 9 of V-2B should be –3.0 VDC minimum. If it is less, Select 126 Mc/s and peak L-301 for maximum negative voltage, then Select 118 Mc. and peak C-304 for maximum negative voltage. Repeat the procedure until the drive is approximately flat across all Mc/s channels.

5-F,2. Low Frequency Oscillator (LFO).

Connect the DC VTVM as shown in the Receiver Test Setup, Figure 4, page 32. The drive at Pin 9 of V-3B should be –3.0 V. dc minimum on any Tenths Mc/s channel. If it is less, Select the 0.0 channel and peak L-329 for maximum negative voltage. The remaining tenths Mc/s positions 0.1 thru 0.9 should then all be in tune.

5-F,3. Intermediate Frequency (IF) Alignments.

In the following several alignment procedures, the results of the signal inputs and tuning procedures will be observed on the AC VTVM connected at the junction of R-124 and C-137. This is the output of the detector CR-103, at TL-20, terminal No. 5. See Photo D, page 36 and the Schematic Figure 7, page 51.

5-F,4. Low Frequency I.F.

Disconnect all components from Pin 9, V-9B, the grid of the second mixer. Connect the MF–HF Signal Generator to Pin 9, V-9B. Terminate the Generator with a 47 ohm resistor and feed the grid through a .047 μf capacitor. A 4.0 Mc/s signal at 300 μv, 400 cps, 30% modulation should produce 1.3 volts ac at the detector. If it does not, check the tuning of the LF IF transformers T-103 through T-105. Tune the primary and secondary slugs of all transformers for maximum output at the detector, CR-103. Make sure all cores are on the outer peak.

Reconnect all components to Pin 9, V-9B.

5-F,5. NAV High Frequency I.F.

a. Set the Channel Selector to 108.5 Mc/s.

b. Disconnect all components from Pin 2, V-2A and connect the Signal Generator to Pin 2. Terminate the Generator with a 47 ohm resistor and feed the grid through a .047 uf capacitor. (Refer to Crystal Frequency Table I, page 29.) Note the HF IF Frequency for the 0.5 Mc/s channel.

c. Set the MF/HF Signal Generator to the Selected frequency. A level of 20 μv (400 cps, 30% modulation) should produce approximately 0.5V. ac at the detector output, CR-103.

d. Now set the tenths Mc/s dial to the 0.0 channel. Set the Generator to the proper frequency and repeak the primary and secondary by adjusting the cores for maximum output at the detector, CR-103.

e. Reset the tenths Mc/s dial to the 0.9 channel. Reset Generators to the proper frequency and again repeak for maximum output at the detector, CR-103.

f. Check the output at the 0.0, 0.5, and 0.9 Mc/s points. Output at the 0.0 and 0.9 Mc/s points should be approximately the same. Output at the 0.5 Mc/s channel should be about 1 db below the end point values.

5-F,6. COM High Frequency I.F.

a. Set the Channel Selector to 118.5 Mc/s and repeat Steps c., thru f., under 5-F,5., above, using the proper HF IF and adjust T-102 to obtain approximately flat output across all tenth Mc/s channels.

b. Reconnect all components to Pin 2, V-2A.

5-F,7. Audio Circuits.

As noted under 5-E,1,f., above a signal of 6 microvolts to the input of the receiver should produce an audio signal of 1.3 volts at the output of the detector, CR-103, on all COM Channels. With the receiver volume control at maximum the above signal should provide a 0.25 Volt signal at the grid of the first audio amplifier V-6A, terminal 2. This in turn should provide a signal of 15 volts at the grid of the output amplifier V-7, terminal 6.

With the above condition the audio level across the RED and ORANGE leads of T-403 should be about 150 volts. This should provide about 2.5 watts of audio power to a loud speaker having an impedance between 3 and 6 ohms.

5-F,8. Automatic Volume Control (AVC).

The AVC threshold is that point at which the AVC line starts to go negative as a result of a signal increase. It may be measured at TL-20, Terminal 3. See Photo D, page 36.

The AVC line should start to go negative when the detector, CR-103, output level reaches 1.3V., ac ±0.1 V., ac. The detector output level may be measured at the junction of R-124 and C-139, which is located on TL-20, Terminal 5. See Photo D, page 36.

The AVC threshold is controlled by the value of R-117. One end of R-117 may be located on TL-20, Terminal 3.

The AVC characteristic is such that a change of signal input level from 10 μv to 10,000 μv should produce a maximum of 4 db increase in the audio output signal.

5-G. TRANSMITTER ADJUSTMENT PROCEDURES.

5-G,1. High Frequency Oscillator (HFO).

With the equipment connected as shown in the Transmitter Test Setup Diagram, Figure 5, page 32 refer to the Schematic Diagram, Figure 7, page 51. The drive at the grid of V-6B, Pin 9, should be –3.0 V.dc minimum on all COM Mc/s channels. If it is less, select 126 Mc/s and peak L-308 for maximum voltage. Then, select 118 Mc/s and peak C-310 for maximum voltage. Repeat this procedure until the drive is approximately flat over all Mc/s channels.

5-G,2. High Frequency (HF) Doubler.

The rf voltage at the grid of the H.F. Doubler should be approximately 3 volts RMS. It may be measured with the DC VTVM and its Diode Probe.

5-G,3. Low Frequency Oscillator (LFO).

The drive at the grid of V-3B should be at least –3.0 V. dc measured through a 1 megohm resistor in series with the VTVM. If it is less, Select the 0.0 Kc/s channel and peak L-329 for maximum negative voltage. The remaining tenths Mc/s positions 0.1 thru 0.9 should then all be in tune.

5-G,4. Balanced Mixer.

The Balanced Mixer involving Q-301 and Q-302 receives energy from both the transmitter HF Doubler, V-1B, and the common LFO, V-3B. Energy levels from the HF Doubler and LFO are quite low. They can be measured with the DC VTVM and its Diode Probe.

a. To measure the level from the LFO de-activate the HF Doubler by removing the tube V-6. The voltages at the bases of Q-301 and -302 should be alike and approximately 0.15 volt RMS.

   If the voltage is too low the adjustment of L-313 should be peaked at 126.5 Mc/s and C-319 should be peaked at 118.5 Mc/s. See Photo D, page 36. These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

   Replace V-6 as soon as the measurement is completed.

b. To measure the level from the HF Doubler deactivate the LFO by removing the tube V-3. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.25 Volt RMS.

   Replace V-3 as soon as the measurement is completed.

c. The combined voltages from the LFO and the HF Doubler at the bases of Q-301 and Q-302 should be alike and approximately 0.5 Volt RMS.

5-G,5. Buffer.

The buffer stage, V-5B, receives its grid drive from the output of the Balanced Mixer, Q-301 and Q-302. This drive is at the desired transmitter output frequency, but at a low level. It may be measured with the DC VTVM and its Diode Probe, at terminal 2 of V-5B. The voltage should be about 1.0 Volt RMS.

If the voltage is too low L-330 should be peaked at 126.5 Mc/s and C-323 at 118.5 Mc/s. See Photo D, These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

NOTE: Allowance should be made for some loading effect of the probe connection. This may be done by re-checking the peaking with the probe connection on the Driver grid (V-11, terminal 7).

5-G,6. Driver.

The voltage at the grid of the driver, V-11, pin 7, should be –0.3 V. dc minimum. If it is less, proceed as follows:

1. Select the 0.5 Mc/s position on the tenths Mc/s Selector.
2. Select the 126 Mc/s position on the Mc/s Selector and peak L-313, L-330, and L-318 for maximum negative volts at Pin 7 of V-11 (through a 1 megohm resistor).
3. Select the 118 Mc/s position on the Mc/s Selector and peak C-319, 323 and C-325 for maximum negative volts at Pin 7, V-11.
4. Repeat the above procedure until the drive is approximately flat across all Mc/s channels.

5-G,7. Final Amplifier.

The drive at junction of L-325, R-321, R-330, and C-352 should be at least –45 VDC. If it is less, select the 126 Mc/s channel and peak L-322 for maximum negative volts at the junction of the above components. Then, select the 118 Mc/s channel and peak C-333 for maximum negative volts. Repeat the procedure until the drive is approximately flat across all Mc/s channels.

5-G,8. Modulator.

The transmitter final output amplifier V-12, a type 7701 tube, is modulated by the common Audio Amplifier tube, V-7, via a winding on the output of the transformer T-403.

The audio voice signal from the microphone goes via C-406 to the grid of the first audio stage, V-6A, terminal 2. The level at this point should be about 0.25 volts audio. The level at the grid of V-12, terminal 6, should be about 15 volts audio.

With the above condition the audio level across the RED and ORANGE primary leads on T-403 should be about 150 volts. This represents approximately 5 watts of audio modulation power.

5-H. OMNI CIRCUITS.

5-H,1. Reference Channel Alignment.

To Check the Omni Reference Channel Alignment proceed as follows:

a. Connect the test equipment to the receiver as described under 5-E., Above.

b. Connect an oscilloscope to Pin 9 of V-10B.

c. Locate the discriminator transformer T-202. Adjust the primary and secondary cores for maximum undistorted signal as noted on the scope. If, in the process of peaking the primary and secondary slugs, the TO-FROM flag changes direction, you have tuned on a false peak. Look for another peak which will give maximum amplitude without causing the TO-FROM flag to change direction. This is the proper setting.

5-H,2. Variable Phase Alignment.

a. Set the receiver course selector dial to 270°. Set the OMNI Generator dial to 270° also.

b. Locate the OMNI Zero Set Control (R-214) marked "OMNI" Photo E page 32. Turn this control to center the Left-Right Indicator.

c. Change the OMNI Generator setting 180° (to 90°) and note if there is any reciprocal error. If there is an error greater than ±4° the meter rectifier balance should be checked.

5-H,3. Rectifier Balance.

To balance the Left-Right Indicator rectifiers proceed as follows:

a. Locate the R-247 & R-248 (470 ohm) on the OMNI board. Photo G, page 38.

b. Compensate either R-242 or R-248 whichever one will allow the meter to center (compensating resistor values of 22K ohm or less, depending on the amount of receiprocal error.)

c. Recheck "TO" course and "FROM" course and adjust compensating resistor value for minimum amount of error.

5-H,4. Localizer Centering Adjustment.

a. Set the receiver to a proper Localizer channel and properly set up the OMN Signal Generator for a Localizer Signal. Refer to 5-E,3., above.

b. The only compensation available for centering the Left-Right Indicator is the adjustment marked "LOC", See Photo E, Page 37. Turn this adjustment (R-226) to center the needle.

5-I. PRINTED CIRCUIT METHODS.

Printer circuits are very reliable and serviceable when they are properly designed, installed and maintained. However, they may be easily damaged by improper maintenance procedures. The following methods if carefully observed will insure satisfactory repairs.

5-I,1. Tools Required.

a. Soldering Iron, small, 40 watts or less.

b. Small Long Nose Pliers.

c. Small Angle Cutters.

d. Small Stiff Bristle Brush, or "solder sipper."

e. Sharp pointed instrument (scriber).

CAUTION:

NEVER place the soldering iron directly on the printed circuit if it can be avoided. EXCESSIVE HEAT will raise the circuit from the board.

5-I,2. Replacement of Small Components.

a. Cut the leads and remove the component from the board.

b. Using the small soldering iron and long nose pliers, lift the remaining ends of the component from the board.

c. With the tip of the iron open the holes in the board by drawing the solder away from the holes.

d. Bend the leads of the replacement component and fit them through the holes (observing polarity, if any.

e. Cut off any excess lead length.

f. Observe that contact surfaces are clean, then resolder.

5-1,3. Replacement of Transistors and Crystals.

a. Heat the leads one at a time and remove the solder with a stiff brush or a "solder sipper."

b. Remove the transistor or crystal by pulling and rocking it gently, while touching the leads with the soldering iron if necessary.

c. Clear the holes of solder and insert the replacement, orienting the connection properly.

d. Observe that contact surfaces are clean then resolder.

CAUTION:

Transistors and Crystals may be damaged by overheating. Use the minimum heat that will still permit rapid removal or replacement.

5-1,4. Replacement of Large Components.

a. Heat each joint enough to soften the solder and using the stiff brush, or "solder sipper," remove the solder. Do only one joint at a time, or only as large an area as will require a minimum of heat.

b. GENTLY pull the defective part from the board when all joints have been cleared.

c. Clear the holes and insert the replacement component, orienting correctly.

d. Observe that contact surfaces are clean then resolder.

NOTE—The brushing, or "solder sipping" method described under a. above may be used to remove any component where it is undesirable or impossible to cut the leads.

FAU

TABLE I

RECEIVER FREQUENCY CHART

KK CORRELATION CRYSTALS

1. For Receiver Ranges 108.0 thru 117.9, HF IF = 2xHFO Minus Input Signal Freq. LF IF = HF IF Minus LFO
2. For Receiver Ranges 118.0 thru 126.9, HF IF = 2xHFO Minus Input Signal Freq. LF IF = LFO Minus HF IF

Input Signal Mc/s	HFO Crystal XT. No.	HFO Frequency Mc/s	2xHFO	HF IF Mc/s	LFO Crystal XT. No.	LFO Frequency Mc/s	LF IF Mc/s
108.0	301	62.76575	125.5315	17.5315	311	13.5315	4.0
108.1	"	"	"	17.4315	310	13.4315	"
108.2	"	"	"	17.3315	309	13.3315	"
108.3	"	"	"	17.2315	308	13.2315	"
108.4	"	"	"	17.1215	307	13.1315	"
108.5	"	"	"	17.1315	306	13.0315	"
108.6	"	"	"	16.9315	305	12.9315	"
108.7	"	"	"	16.8315	304	12.8315	"
108.8	"	"	"	16.7315	303	12.7315	"
108.9	"	"	"	16.6315	302	12.6315	"
109.0	302	63.26575	126.5315	17.5315	311	13.5315	4.0
110.0	303	63.76575	127.5315	"	"	"	"
111.0	304	64.26575	128.5315	"	"	"	"
112.0	305	64.76575	129.5315	"	"	"	"
113.0	306	65.26575	130.5315	"	"	"	"
114.0	307	65.76575	131.5315	"	"	"	"
115.0	308	66.26575	132.5315	"	"	"	"
116.0	309	66.76575	133. 5315	"	"	"	"
117.0	310	67.26575	134.5315	"	"	"	"
118.0	303	63.76575	127.5315	9.5315	311	13.5315	4.0
118.1	"	"	"	9.4315	310	13.4315	"
118.2	"	"	"	9.3315	309	13.3315	"
118.3	"	"	"	9.2315	308	13.2315	"
118.4	"	"	"	9.1315	307	13.1315	"
118.5	"	"	"	9.0315	306	13.0315	"
118.6	"	"	"	8.9315	305	12.9315	"
118.7	"	"	"	8.8315	304	12.8315	"
118.8	"	"	"	8.7315	303	12.7315	"
118.9	"	"	"	8.6315	302	12.6315	"
119.0	304	64.26575	128.5315	9.5315	311	13.5315	4.0
120.0	305	64.76575	129.5315	"	"	"	"
121.0	306	65.26575	130.5315	"	"	"	"
122.0	307	65.76575	131.5315	"	"	"	"
123.0	308	66.26575	132.5315	"	"	"	"
124.0	309	66.76575	133.5315	"	"	"	"
125.0	310	67.26575	134.5315	"	"	"	"
126.0	311	67.76575	135.5315	"	"	"	"

TABLE II

TRANSMITTER FREQUENCY CHART

KK CORRELATION CRYSTALS

For the Transmitter Range of 118.0 thru 126.9 the Output Frequency equals 2xHFO Minus LFO.

LFO Crystal XT. No.	LFO Frequency Mc/s	HFO Crystal XT. No.	HFO Frequency Mc/s	2xHFO	Transmitter Output Frequency
311	13.5315	307	65.76575	131.5315	118.0
310	13.4315	"	"	"	118.1
309	13.3315	"	"	"	118.2
308	13.2315	"	"	"	118.3
307	13.1315	"	"	"	118.4
306	13.0315	"	"	"	118.5
305	12.9315	"	"	"	118.6
304	12.8315	"	"	"	118.7
303	12.7315	"	"	"	118.8
302	12.6315	"	"	"	118.9
311	13.5315	308	66.26575	132.5315	119.0
"	"	309	66.76575	133.5315	120.0
"	"	310	67.26575	134.5315	121.0
"	"	311	67.76575	135.5315	122.0
"	"	312	68.26575	136.5315	123.0
"	"	313	68.76575	137.5315	124.0
"	"	314	69.26575	138.5315	125.0
"	"	315	69.76575	139.5315	126.0
★See Note		316	61.05	122.1	122.1

★NOTE: Refer to 4A, INTRODUCTION and 4B, CIRCUIT ARRANGEMENT, page 15.

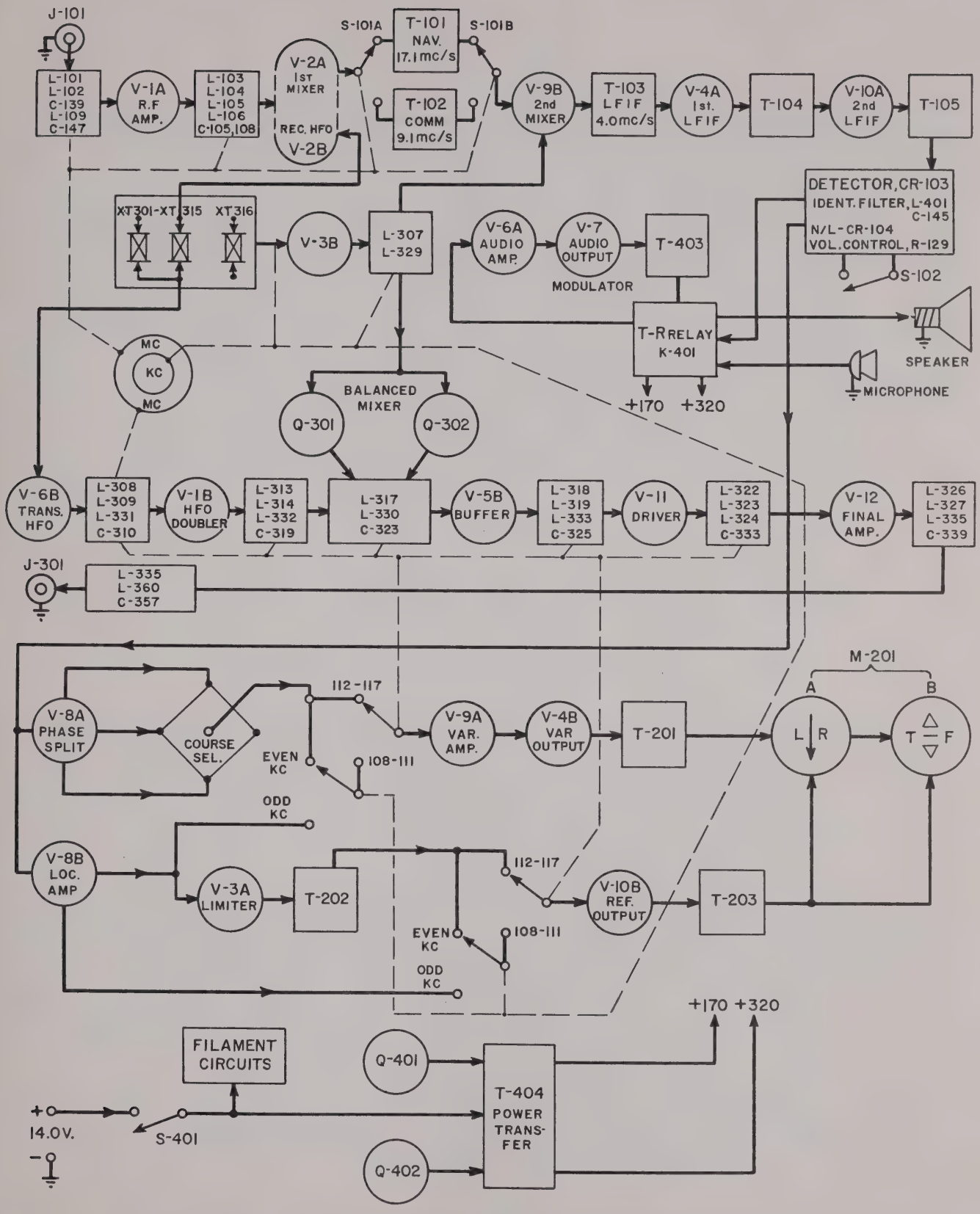


Figure 3. BLOCK DIAGRAM, *narco* Mark-III Equipment.

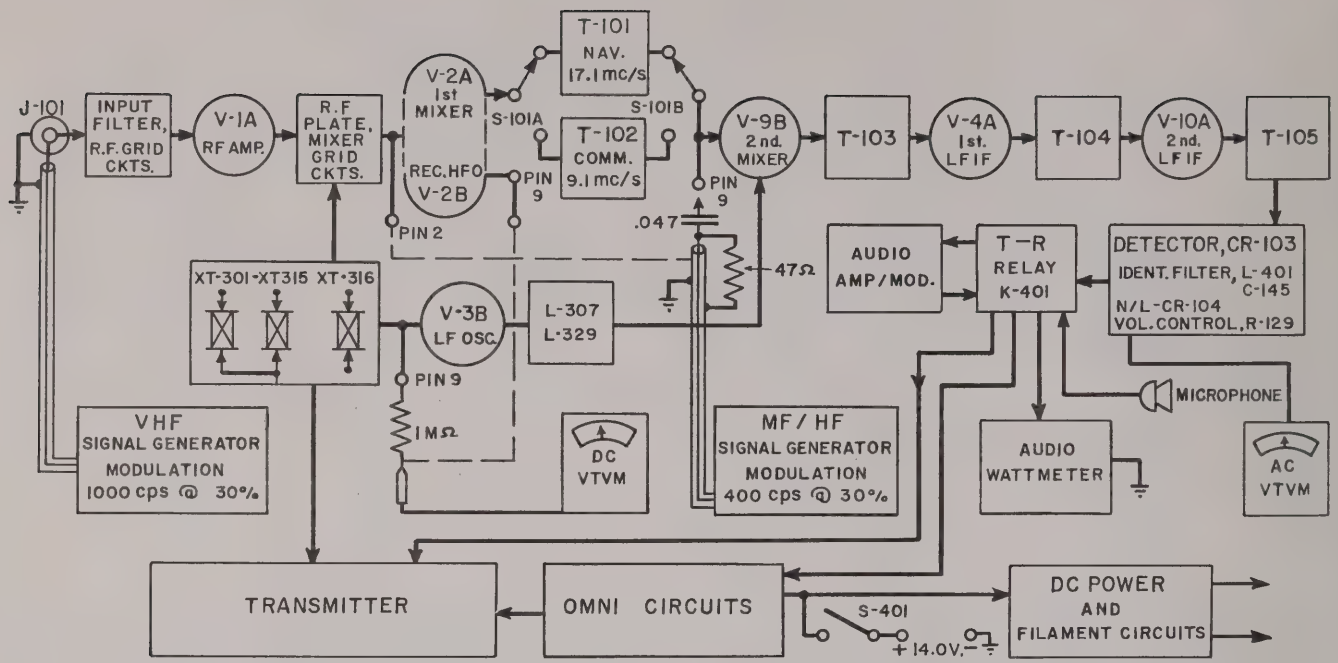


Figure 4. RECEIVER TEST SETUP, *narco* Mark-III Equipment.

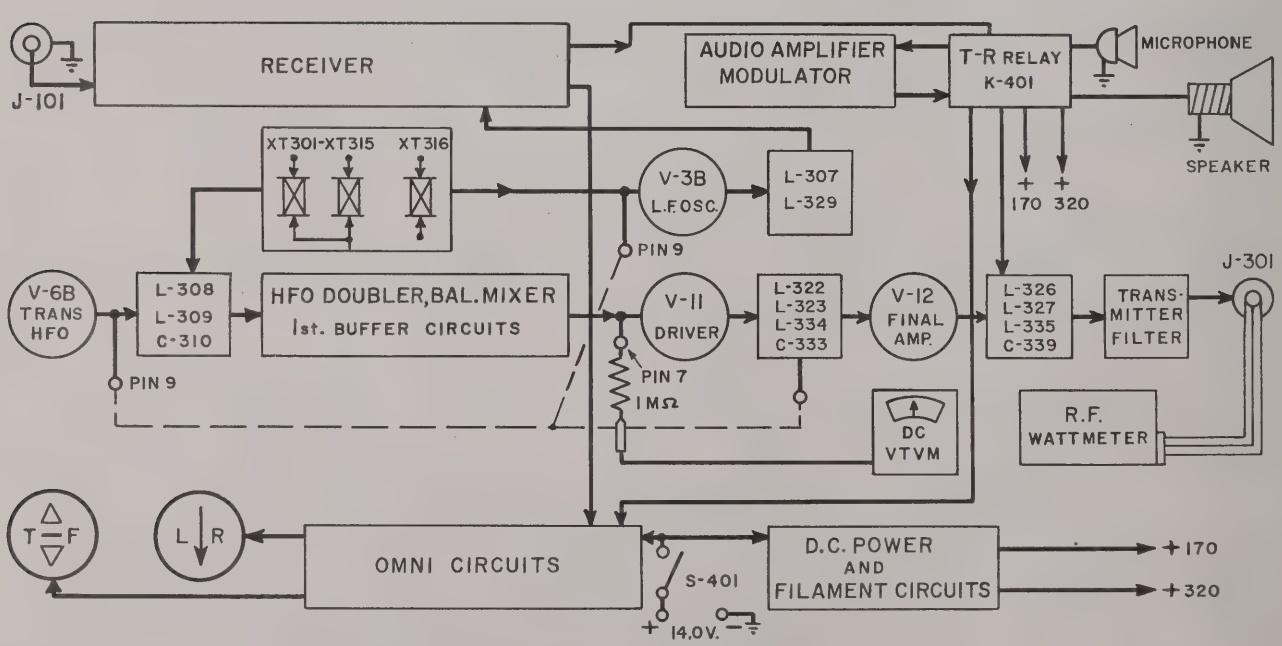


Figure 5. TRANSMITTER TEST SETUP, *narco* Mark-III Equipment.

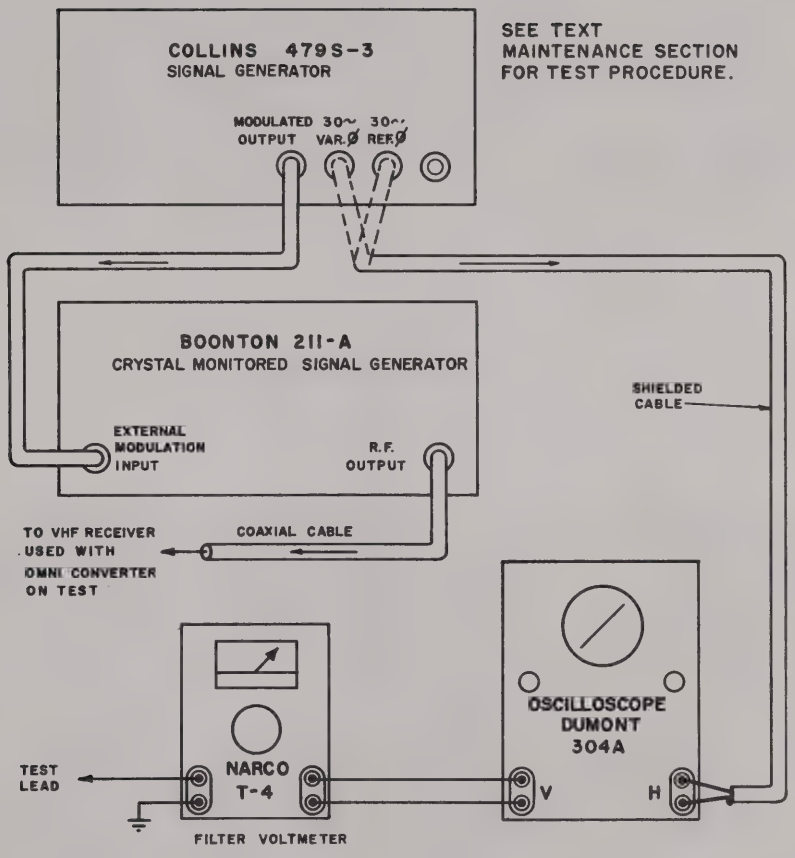


Figure 6. OMNI TEST SETUP, *narco* Mark-III Equipment For Phase Angle Measurements.

6-C. PHOTOS.

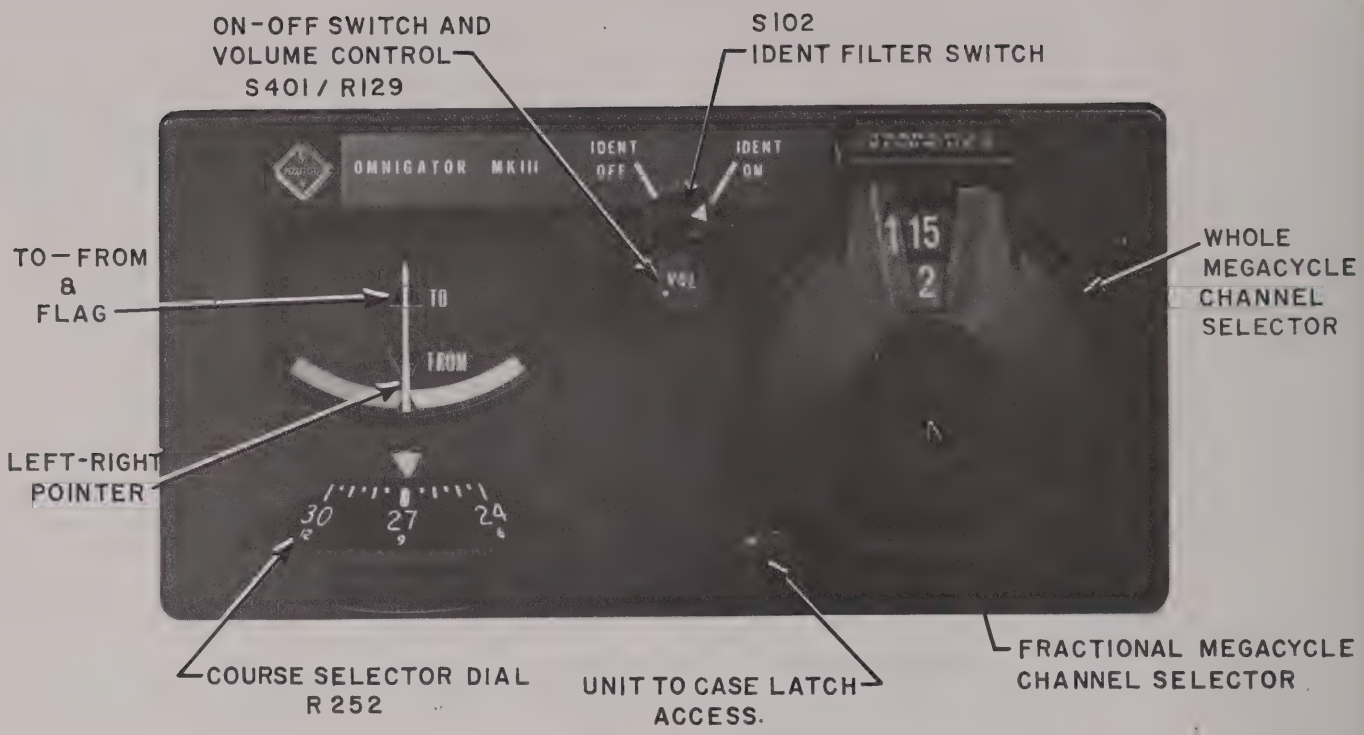


Photo A.
FRONT PANEL VIEW, *narco* Mark-III Equipment.

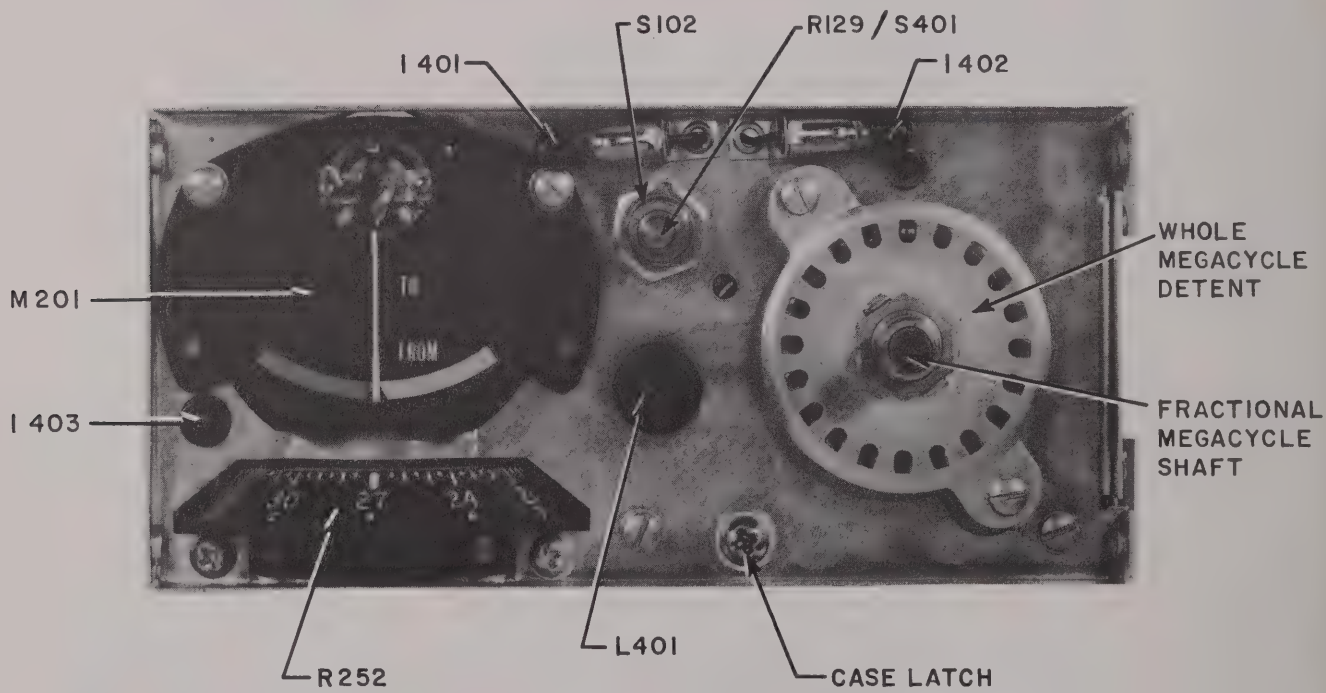


Photo B.
FRONT VIEW, without Trim Panel.
narco Mark-III Equipment.

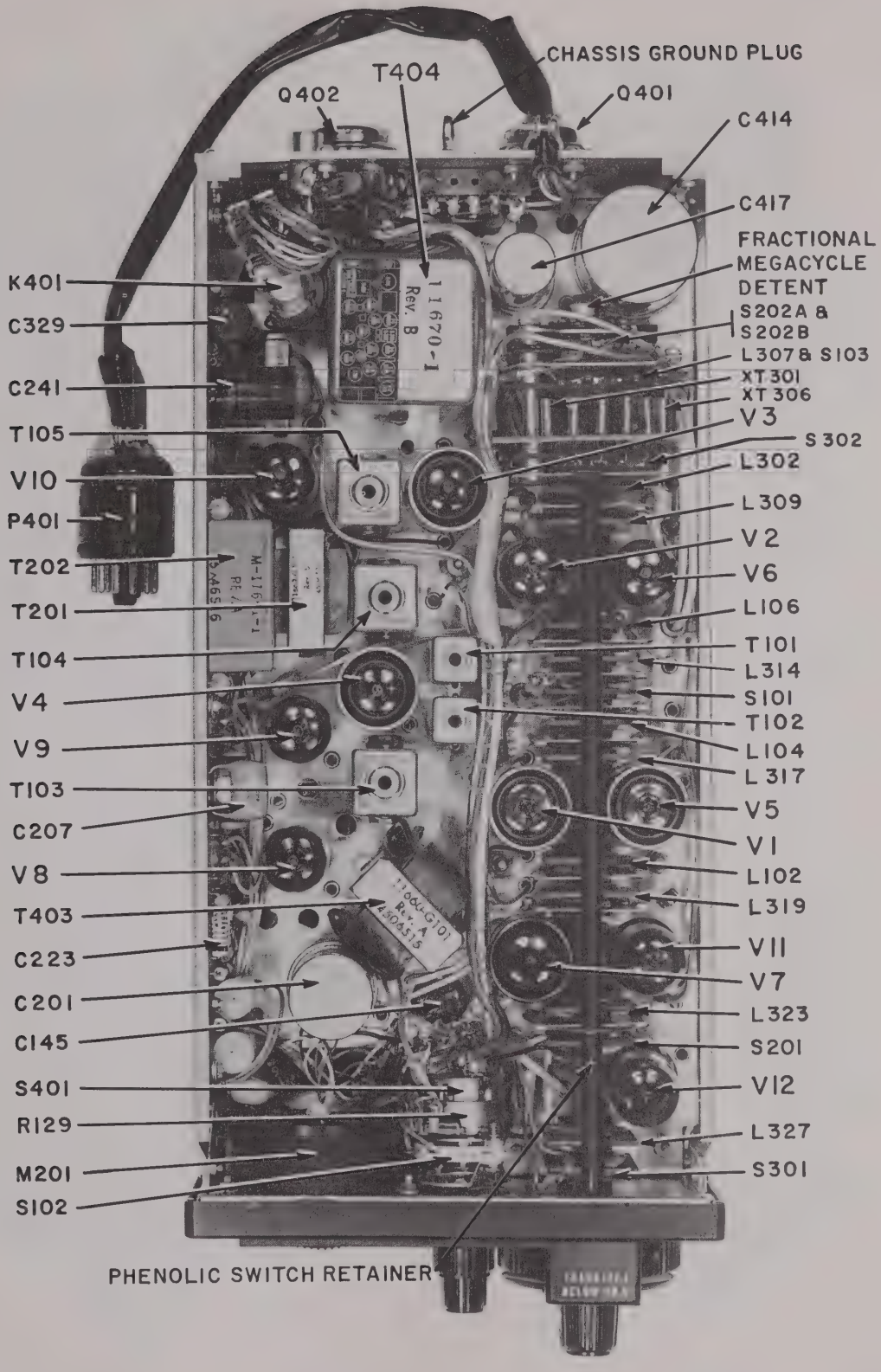


Photo C.
TOP VIEW, *narco* Mark-III Equipment.

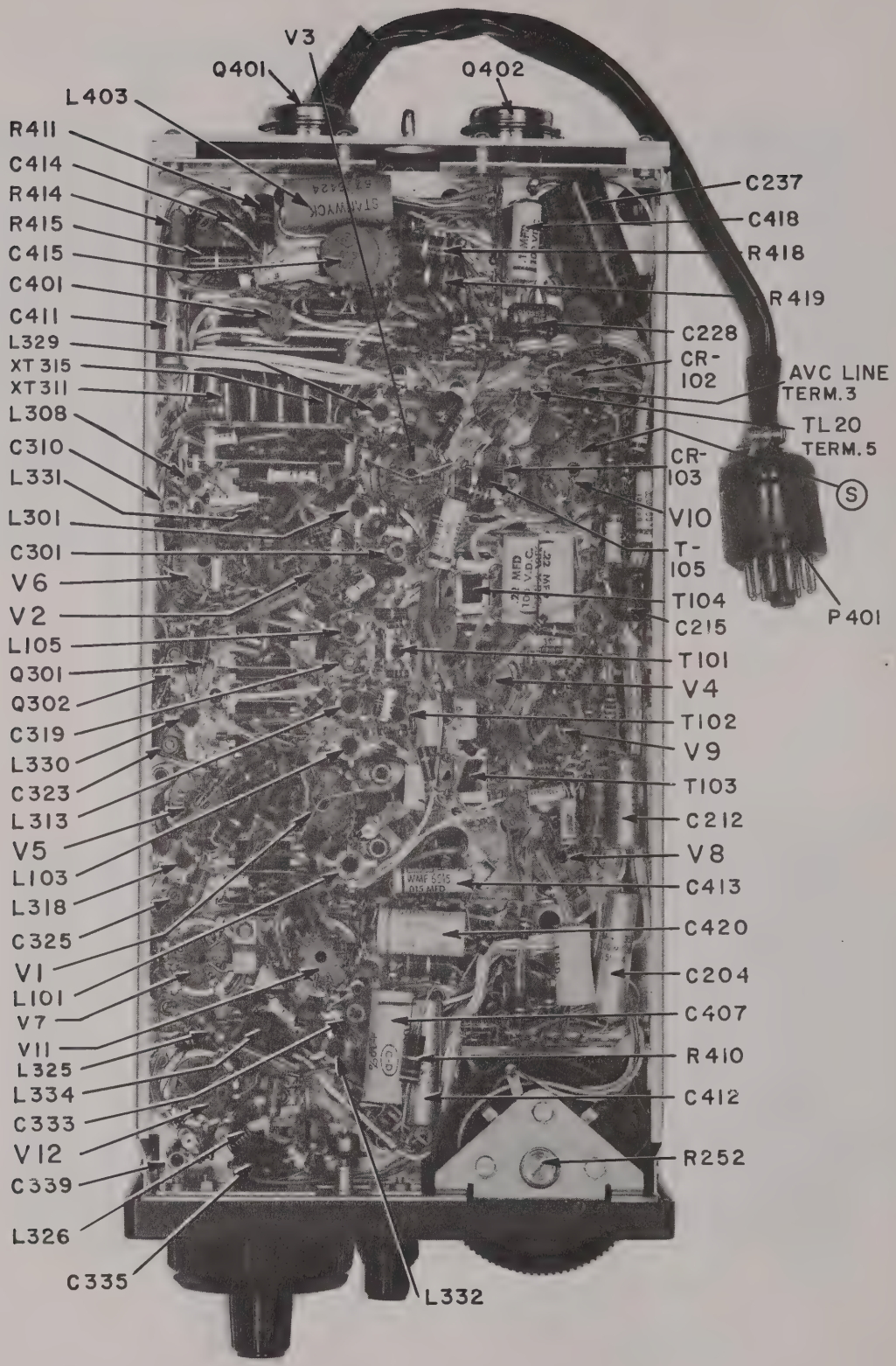


Photo D.
BOTTOM VIEW, *narco* Mark-III Equipment.

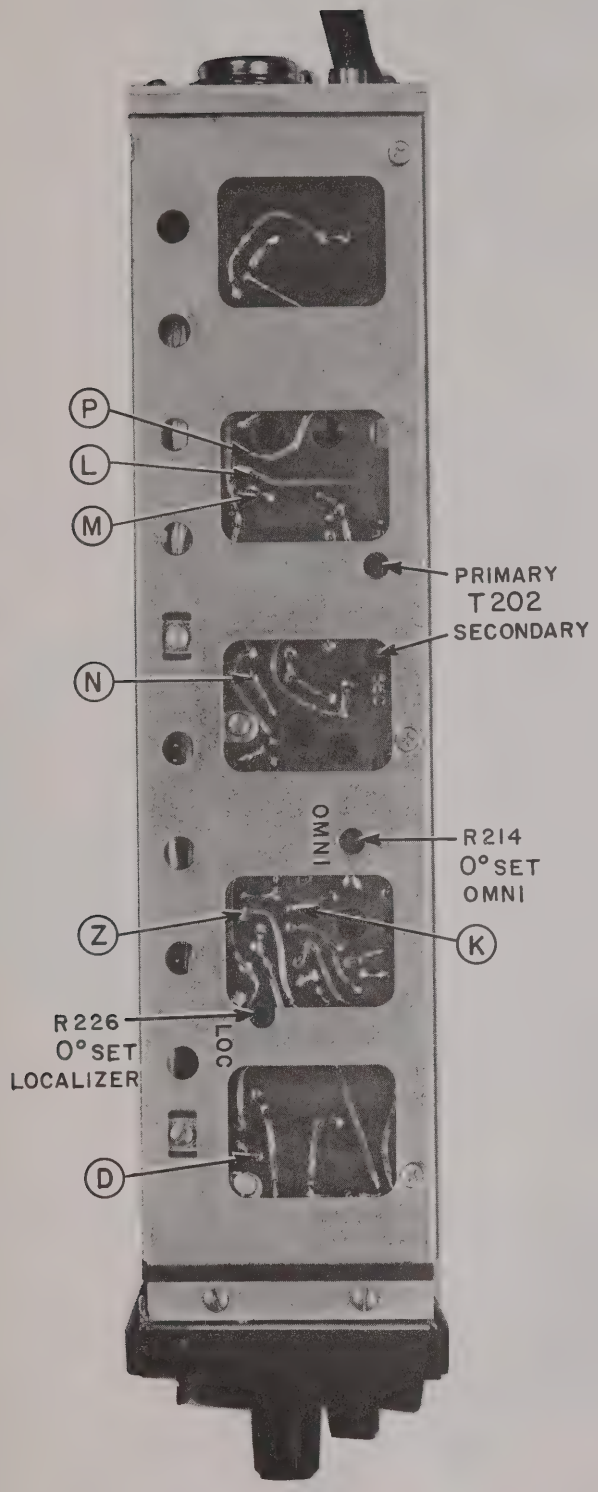


Photo E.
LEFT SIDE VIEW.

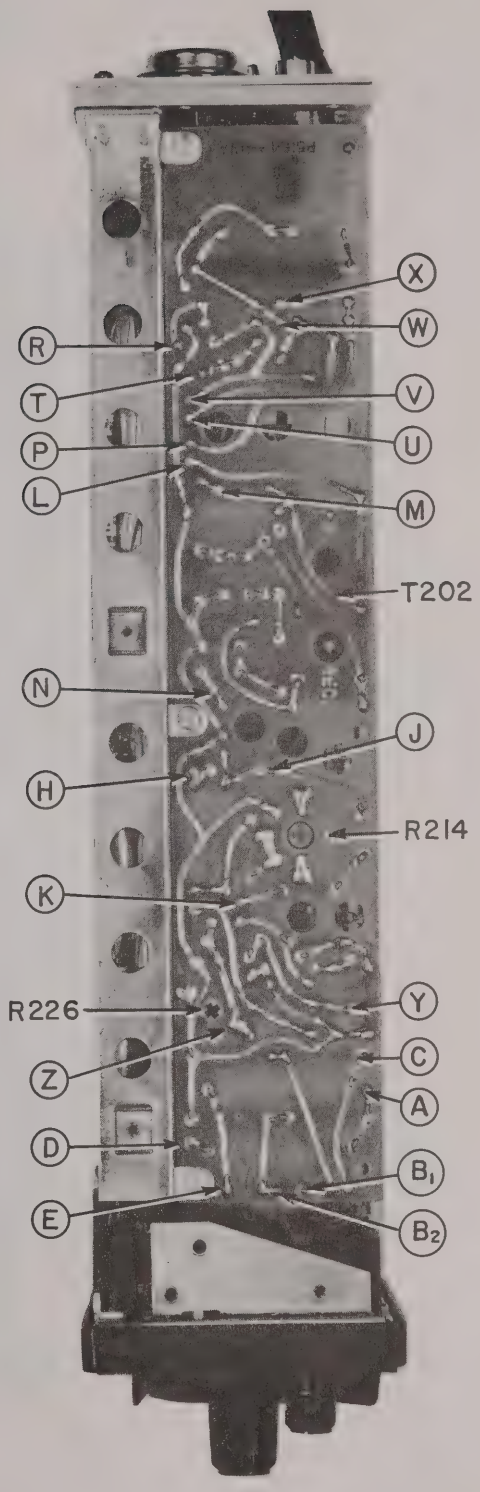


Photo F.
OMNI BOARD, Circuit Side
narco Mark-III Equipment.

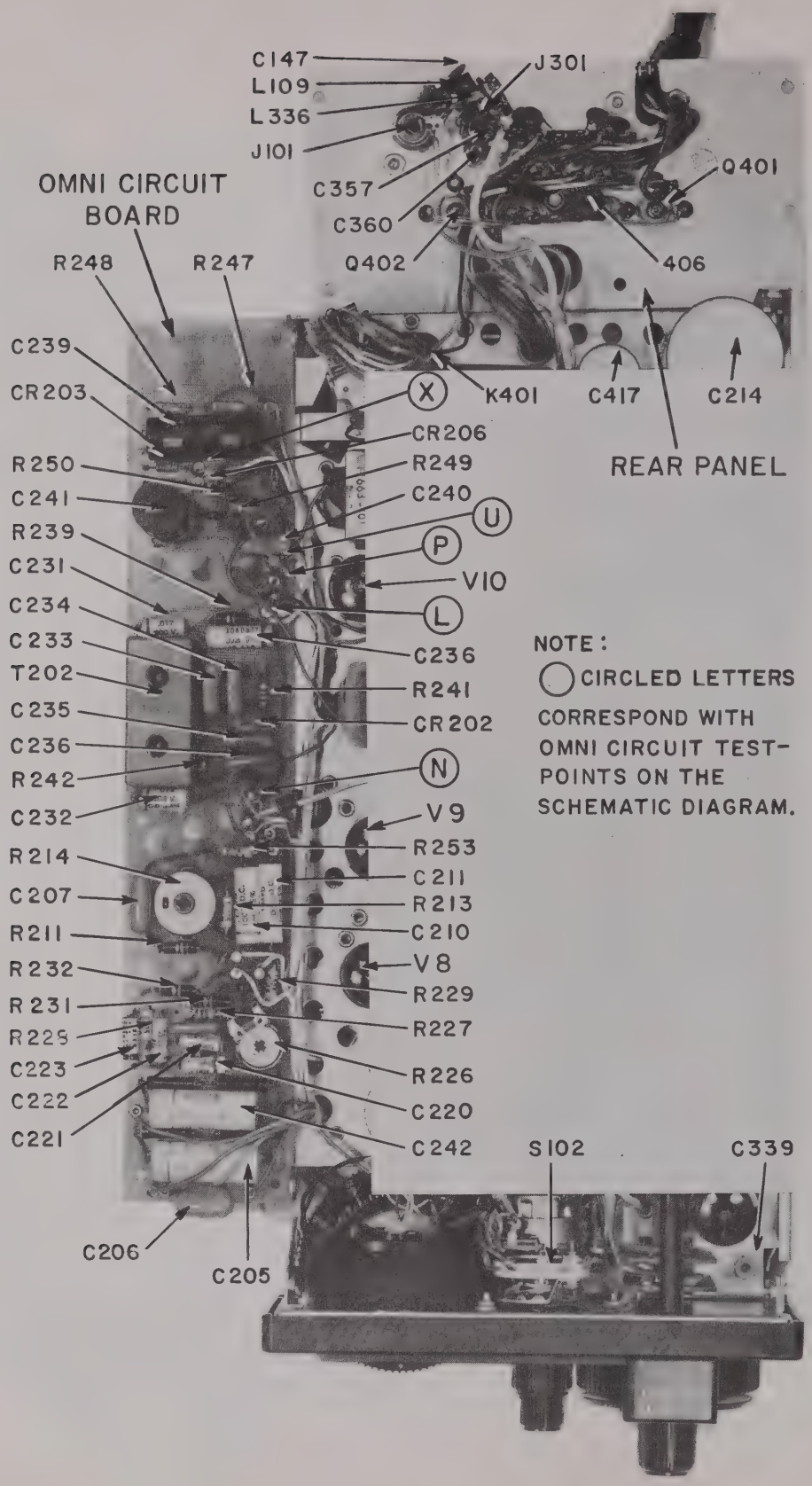


Photo G.
OMNI BOARD (Component Side), and REAR PANEL
narco Mark-III Equipment.

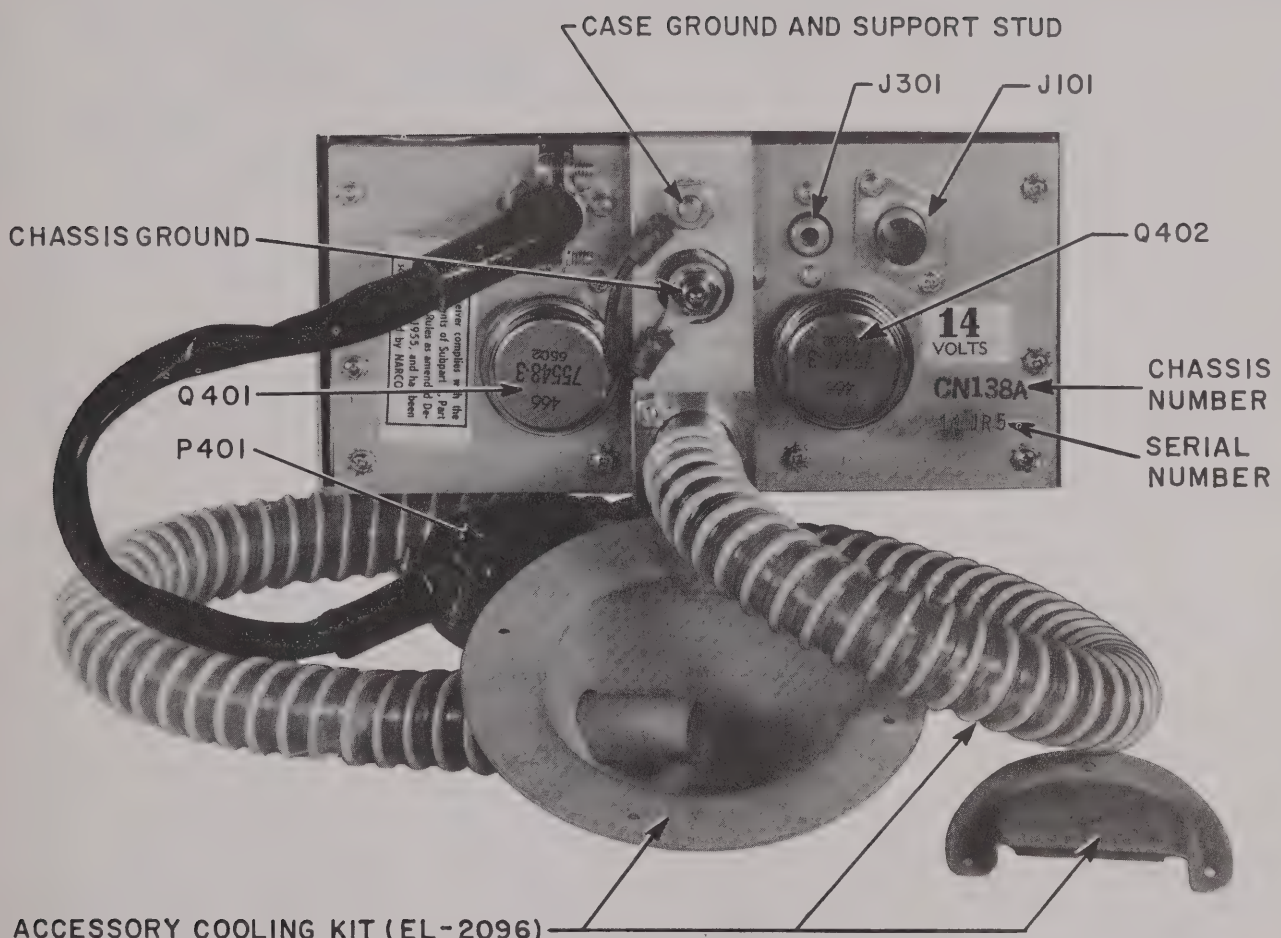


Photo H.
REAR VIEW, with CASE and COOLING KIT.
narco Mark-III Equipment.

SECTION 7
REPLACEMENT PARTS

7-A. INTRODUCTION.

This list of Replacement Parts contains the items that may be considered replaceable in the field. They should preferably be ordered by Symbol No., ***narco*** Part No., and Description.

The Replacement Parts are listed by their Symbol letter and number, alphabetically then numerically. Items without a Symbol No., are listed numerically by Part Number in a "Miscellaneous" List following the listings by Symbol numbers. A few items without a Symbol No. may be listed with associated parts such as connectors.

The "Function or Application" column is intended to separate the description of the item from its purpose in the equipment. It also serves to identify "NO SYMBOL" items in the "Miscellaneous" List. In addition it will also be found useful when working with the illustrations and Schematics.

7-B. LIST OF REPLACEMENT PARTS.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-101	21291-21	Ceramic Disc., 1000V .001μf, ±20%	Bypass
C-102	21291-24	Ceramic Disc., 500V 270pf ±20%	Bypass
C-103	21291-21	Same as C-101	Bypass
C-104	21291-25	Ceramic Disc., 500V 430 pf, ±20%	Bypass
C-105	22019-1	Ceramic Trimmer, 0.5-4 .5pf	Rec. R.F. Amp., Plate
C-106	24509-338	Ceramic Tubular, 500V .33 pf, ±5%	Rec. R.F. Amp., Output.
C-107	21201-829	Ceramic Tubular, 500V 8.2 pf	Rec. 1st Mix., In.
C-108	22043-1	Trimmer .7-3PF	
C-109	21291-14	Ceramic Disc., 500V, 100 pf, ±10%	
C-110	21291-21	Same as C-101	
C-111	21291-18	Ceramic Disc., 500V, 330 pf, ±20%	
C-112	21291-8	Ceramic Disc., 500V .003μf, ±20%	
C-113	23085-163	Mylar 200V, .01μf, ±10%	
C-114		Not Used	
C-115	24509-109	Ceramic Tubular, 500V, 1.0 pf, ±5%	
C-116	24515-1	Ceramic Disc., 1μf +80% -20%, 10V	
C-117	21206-120	Ceramic Tubular, 500V, 12.0 pf, N470	
C-118	21206-120	Same as C-117	
C-119	21291-6	Ceramic Disc, 500V .01μf, GMV	
C-120	23085-163	Same as C-113	
C-121	23085-79	Mylar 100V, .22μf, ±10%	
C-122	21291-6	Same as C-119	
C-123	24515-1	Same as C-116	
C-124		Not Used	
C-125	21206-120	Same as C-117	
C-126	21206-120	Same as C-117	
C-127	21291-8	Same as C-112	
C-128		Not Used	
C-129	23085-163	Same as C-113	
C-130	23085-79	Same as C-121	
C-131	21206-120	Same as C-117	
C-132	21291-6	Same as C-119	
C-133	24515-1	Same as C-116	
C-134		Not Used	
C-135	21206-120	Same as C-117	
C-136	21291-14	Same as C-109	
C-137	21291-14	Same as C-109	
C-138	23085-25	Mylar 100V, .1μf, ±20%	
C-139	22019-1	Same as C-105	
C-140	21201-229	Ceramic Tubular, 2.2 pf NPO 500V.	
C-141		Not Used	
C-142		Not Used	
C-143		Not Used	
C-144	23085-171	Mylar 200V .047μf, ±10%	
C-145	24045-512	Dipped Mica 300V 5100pf, ±5%	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS (Continued)	
C-146		Not Used	
C-147		Part of L-109	
C-201	21525-28	Electrolytic, 20/350V, 40/200V., 20/200V.	
C-202	23085-155	Mylar 200V, .0022 μf, ± 10%	
C-203	23085-155	Same as C-202	
C-204	21554-7	Tubular Electrolytic Ins. 16μf/150V	
C-205	23077-1	Mylar 50V .43μf, ± 1%	
C-206	23091-80	Mylar 75V .27μf, ± 10%	
C-207	23091-79	Mylar 75V .22μf, ± 10%	
C-208	23085-63	Mylar 100V .01 μf ± 10%	
C-209	23091-70	Mylar 100V .039 μf, ± 10%	
C-210	23085-425	Mylar 100V .1μf, ± 5%	
C-211	23085-425	Mylar 100V .1 μf, ± 5%	
C-212	21524-53	Tubular Electro., 300/3V	
C-213	23085-163	Same as C-113	
C-214	23085-159	Mylar 200V .0047 μf, ± 10%	
C-215	24045-152	Dipped Mica 500V 1500 pf, ± 5%	
C-216	21291-11	Ceramic Disc., 500V 200 pf, ± 10%	
C-217	23085-159	Same as C-214	
C-218	23085-155	Same as C-202	
C-219	23085-175	Mylar 200V .1MF ± 10%	
C-220	23085-409	Mylar 100V .0047μf, ± 5%	
C-221	23085-409	Mylar 100V .0047 μf, ± 5%	
C-222	23085-413	Mylar 100V .01 μf, ± 5%	
C-223	23085-159	Same as C-214	
C-224	21291-11	Same as C-216	
C-225	21291-11	Same as C-216	
C-226	23085-63	Same as C-208	
C-227	21291-11	Same as C-216	
C-228	24045-911	Dipped Mica 500V 910 pf, ± 5%	
C-229	23085-171	Same as C-144	
C-230	23085-171	Same as C-144	
C-231.	23085-464	Mylar 200V .012 μf, ± 5%	
C-232	23085-464	Same as C-231	
C-233	23091-71	Mylar 100V .047 μ f, ± 10%	
C-234	23091-71	Same as C-233	
C-235	23091-69	Mylar 100V .033 μf, ± 10%	
C-236	23091-75	Mylar 100V .1 μf, ± 10%	
C-237	21524-50	Electro, 250 μf, 50V	
C-238		Not Used	
C-239	21547-5	Same as C-233	Meter Damping.
C-240	23091-71	Same as C-233	
C-241	21547-1	Electro. 500 μf, 0.1V NP	Meter Damping.
C-242	23077-1	Same as C-205	
C-243	21291-21	Same as C-101	
C-244	21291-21	Same as C-101	
C-301	24049-121	Dipped Mica 500V 120 pf, ± 5%	
C-302	21211-560	Ceramic Tubular 500V 56 pf, ± 10%	
C-303	21291-25	Same as C-104	
C-304	22019-1	Same as C-105	
C-305	21201-220	Ceramic Tubular 500V 22 pf, ± 10%	
C-306	21291-21	Same as C-101	
C-307	24049-331	Dipped Mica 330 pf, 500V 5%	
C-308	21201-829	Same as C-107	
C-309	24049-111	Dipped Mica 110 pf, 500V 5%	
C-310	22019-1	Same as C-105	
C-311	24049-101	Dipped Mica 500V, 100 pf, ± 5%	
C-312	21211-470	Ceramic Tubular, 500V 47 pf, ± 10%	
C-313	21291-21	Same as C-101	
C-314	21291-25	Same as C-104	
C-315	21201-220	Same as C-305	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS, (Continued)	
C-316	21201-100	Ceramic Tubular, 500V 10 pf, ±10%	
C-317	21291-21	Same as C-101	
C-318	21201-100	Same as C-316	
C-319	22043-1	Same as C-108	
C-320	21291-21	Same as C-101	
C-321	21201-330	Ceramic Tubular, 500V 33 pf, ±10%	
C-322	21201-100	Same as C-316	
C-323	22043-1	Same as C-108	
C-324	21291-24	Same as C-102	
C-325	22043-1	Same as C-108	
C-326	21291-18	Same as C-111	
C-327	21291-21	Same as C-101	
C-328	21211-150	Ceramic Tubular, 500V, 15 pf, ±10%	
C-329	21291-21	Same as C-101	
C-330	21291-21	Same as C-101	
C-331	21291-21	Same as C-101	
C-332	21291-21	Same as C-101	
C-333	22019-1	Same as C-105	
C-334	21291-21	Same as C-101	
C-335	21201-220	Same as C-305	
C-336	21291-21	Same as C-101	
C-337	21291-21	Same as C-101	
C-338	21291-21	Same as C-101	
C-339	22019-1	Same as C-105	
C-340	21291-21	Same as C-101	
C-341	21211-560	Same as C-302	
C-342	24515-1	Same as C-116	
C-343	21201-479	Ceramic Tubular, 500V, 4.7 pf, ±10%	
C-344	21291-6	Same as C-119	
C-345	21291-18	Same as C-111	
C-346	21291-18	Same as C-111	
C-347	21201-180	Ceramic Tubular, 500V, 18 pf, ±10%	
C-348	21201-229	Ceramic Tubular, 500V, 2.2 pf, ±10%	
C-349	21291-21	Same as C-101	
C-350	21291-21	Same as C-101	
C-351	21291-21	Same as C-101	
C-352	21291-21	Same as C-101	
C-353	21291-21	Same as C-101	
C-354	21291-21	Same as C-101	
C-355	21201-159	Not Used.	
C-356	21291-21	Same as C-101	
C-357	21201-330	Same as C-321	
C-358	21291-25	Same as C-104	
C-359	21291-21	Same as C-101	
C-360	21201-330	Same as C-321	
C-361	21291-21	Same as C-101	
C-401		Not Used	
C-402		Not Used	
C-403		Not Used	
C-404	21291-14	Same as C-109	
C-405	21291-8	Same as C-112	
C-406	21291-5	Ceramic Disc., 50V., 10 μf, ±20%	
C-407	23085-83	Mylar 100V .47 μf, ±10%	
C-408	21291-21	Same as C-101	
C-409	21291-8	Same as C-112	
C-410	21291-14	Same as C-109	
C-411	21554-5	Ceramic Tubular Electro 10/175 10 pf, 175V.....1st Audio Screen Bypass.	
C-412	21554-4	Ceramic Tubular Electro 100 μf, 30V.....Audio Output Cathode Bypass.	
C-413	23085-315	Mylar 600V .015 μf, ±20%	
C-414	21556-2	Electrolytic, 60, 20/200V, 30/400V, 15/350V.....Hi and Lo B+Filt.	
C-415	21291-22	Ceramic, Disc., 500V, .005 μf, ±10%	
C-416	21291-22	Same as C-415	
C-417	21525-17	Electrolytic 15V. 400 μf	
C-418	23085-25	Same as C-138	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS, (Continued)	
C-419	21291-6	Same as C-119	
C-420	23085-374	Mylar 600V .082μf, ±20%	
C-421	21291-21	Same as C-101	
C-422	21291-21	Same as C-101	
C-423	21291-21	Same as C-101	
C-424	21291-21	Same as C-101	
C-425	21291-21	Same as C-101	
C-426	21291-21	Same as C-101	
C-427	21291-21	Same as C-101	
C-428	21291-21	Same as C-101	
C-429	21291-21	Same as C-101	
C-430	21291-21	Same as C-101	
C-431	21291-21	Same as C-101	
C-432	21291-21	Same as C-101	
C-433	21291-21	Same as C-101	
C-434	21291-21	Same as C-101	
C-435	21291-21	Same as C-101	
C-436	21291-21	Same as C-101	
C-437	21291-21	Same as C-101	
C-438	21291-21	Same as C-101	
C-439	21291-21	Same as C-101	
C-440	21291-21	Same as C-101	
C-441	21291-21	Same as C-101	
C-442	21291-21	Same as C-101	
C-443	21291-21	Same as C-101	
C-444	21291-21	Same as C-101	
C-445	21291-21	Same as C-101	
C-446	21291-21	Same as C-101	
C-447	21291-14	Same as C-109	
C-448	23085-25	Same as C-138	
C-449	21291-11	Same as C-216	
C-450	21291-21	Same as C-101	
		CR, DIODES	
CR-101		Not Used	
CR-102	75023-1	Diode, Silicon	
CR-103	75019-2	Diode, Silicon	Audio Detector.
CR-104	75013-4	Diode, Silicon	Noise Limiter.
CR-201	75023-1	Same as CR-102	Ratio Detector.
CR-202	75023-1	Same as CR-102	Ratio Detector.
CR-203	75023-1	Same as CR-102	L-R Meter Diode.
CR-204	75023-1	Same as CR-102	To-From Meter Diode.
CR-205	75023-1	Same as CR-102	L-R Meter Diode.
CR-206	75023-1	Same as CR-102	To-From Meter Diode.
CR-301		Not Used	
CR-302		Not Used	
CR-303	75013-6	Diode, Silicon	
CR-401		Not Used	
CR-402	75204-45	Diode Silicon 500V PIV	Bridge Rectifier Assembly.
CR-403	75204-45	Same as CR-402	Bridge Rectifier Assembly.
CR-404	75204-45	Same as CR-402	Bridge Rectifier Assembly.
CR-405	75204-45	Same as CR-402	Bridge Rectifier Assembly.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		I, INDICATORS (LAMPS)	
I-401	None	Lamp, No. 336, 14V, Red	Panel Lamp.
I-402	None	Lamp, No. 336, 14V, Red	Panel Lamp.
I-403	None	Lamp, No. 336, 14V, Red	Panel Lamp.
		J, JACKS (Connectors) (See also P, PLUGS)	
J-101	41143-3	Connector, Chassis, Female	Receiver Antenna
J-301	41110-2	Connector, Chassis, Female	Transmitter Antenna
		K, RELAYS	
K-401	65126-21	Relay, 12V. d.c., 6 PDT	Power & Audio Transmit Receive Switching.
		L, INDUCTORS	
L-101	11483-1	Coil, Antenna	V-2A Grid.
L-102	61436-101	Coil, Var. Inductor, Antenna	L-101 Tracking
L-103	11484-2	Coil, R.F.	V-1A Plate.
L-104	61436-101	Same as L-102	L-103 Tracking.
L-105	11504-2	Coil, HFO Doubler	V-2A Grid.
L-106	61436-101	Same as L-102	L-105 Tracking.
L-107		Not Used	
L-108		Not Used	
L-109	11198-1	Coil. Trap	Rec. Ant. Filter.
L-301	11484-1	Coil, Osc	Receiver HFO
L-302	61450-101	Var. Inductor	HFO Tracking.
L-303	11138-9	RF Choke 2.2 μh	
L-304	11138-3	RF Choke, 22 μh	
L-305	11138-7	RF Choke 1.0 μh	
L-306	11138-5	R.F. choke 0.47 μh	
L-307	61469-101	LFO Var. Ind. & Xtal. Sw.	
L-308	11471-1	Coil, Osc	Trans. HFO
L-309	61443-102	Var. Inductor	HFO Tracking.
L-310	11138-9	Same as L-303	
L-311	11138-3	Same as L-304	
L-312	11138-5	Same as L-306	
L-313	11504-1	Coil, Osc. Doubler	HFO Doubler
L-314	61443-102	Same as L-309	HFO Tracking.
L-315	11138-3	Same as L-304	
L-316	11138-7	Same as L-305	
L-317	61443-102	Same as L-309	Mixer Tracking.
L-318	11474-1	Coil, Buffer	1st Buffer, V-5B
L-319	61443-102	Same as L-309	Buffer Tracking.
L-320	11138-5	Same as L-312	
L-321		Not Used	
L-322	11473-1	Coil, Driver	Driver V-11.
L-323	61443-101	2nd Buffer, Var. Inductor	Driver Tracking.
L-324	11138-5	Same as L-312	
L-325	11138-9	Same as L-303	
L-326	11477-2	Coil, Plate	Final Tank, V-12.
L-327	61443-101	Same as L-323	Final Tracking.
L-328	11138-5	Same as L-312	
L-329	11476-1	Coil, Oscillator	LF Oscillator.
L-330	11475-1	Coil, Mixer	Transmitter Mixer.
L-331	11669-3	Coil, Airwound	For 122.1 Mc
L-332	11669-5	Coil, Airwound, Doubler	For 122.1 Mc
L-333	11669-5	Same as L-332	For 122.1 Mc
L-334	11678-1	Coil, Driver	For 122.1 Mc
L-335	11668-1	Coil, Final Amp.	For 122.1 Mc

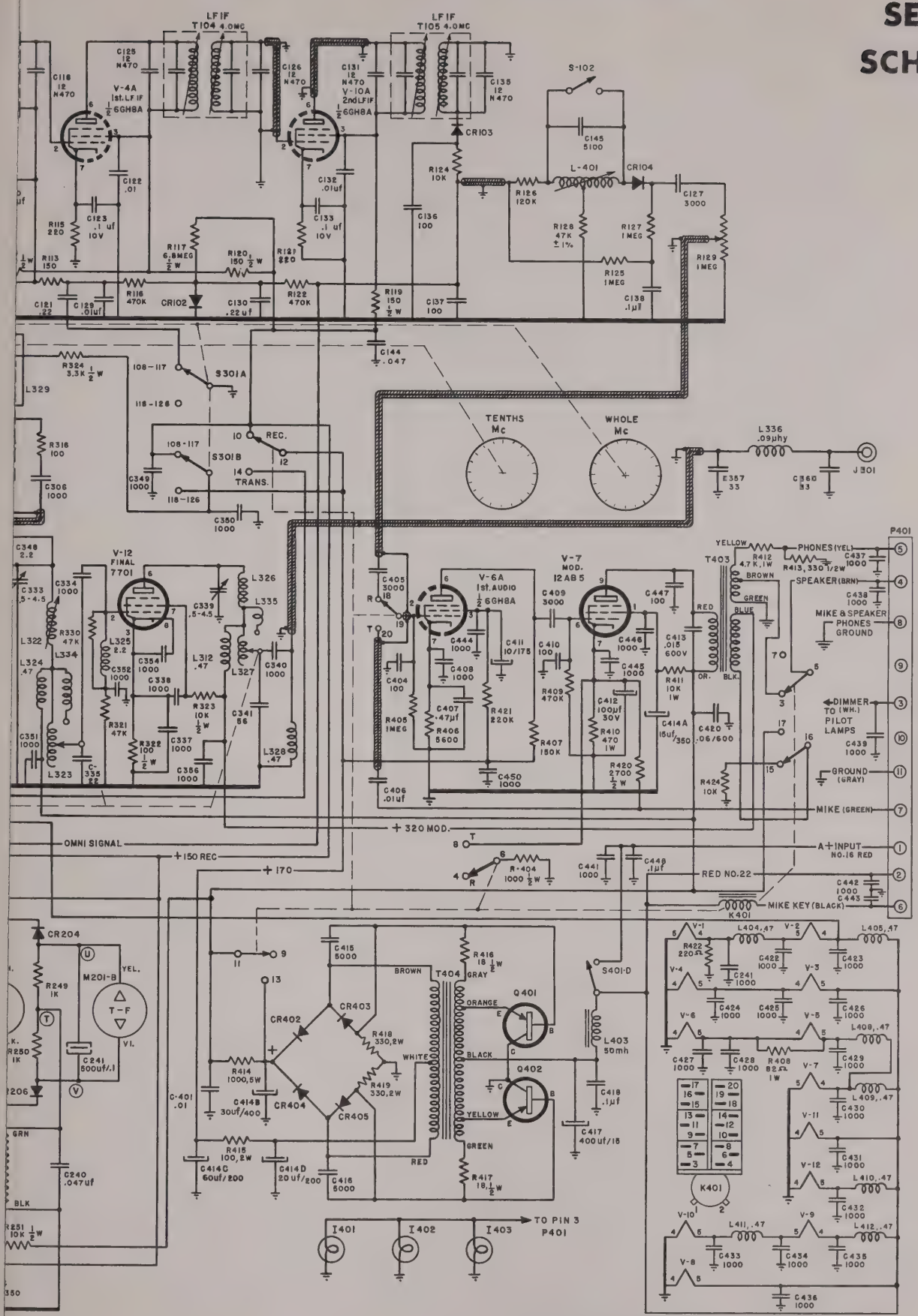
SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		L, INDUCTORS (Continued)	
L-336	11135-9	Choke, RF, 0.09 μh	Transient Filter.
L-401	11446-2	Inductor, Adjustable, 5H, CT	Indent. Filter.
L-402		Not Used	
L-403	11449-1	Choke, Hash 50 μh	At Line Filter
L-404		Not Used	
L-405	11138-5	Same as L-312	
L-406	11138-5	Same as L-312	
L-407		Not Used	
L-408	11138-5	Same as L-312	
L-409	11138-5	Same as L-312	
L-410	11138-5	Same as L-312	
L-411	11138-5	Same as L-312	
L-412	11138-5	Same as L-312	
		M, METERS (Indicators)	
M-201-A	76065-1	Indicator, Dual Purpose	Left-Right
M-201-B		Indicator, Dual Purpose (Part of M-201A	To-From
		P, PLUGS (Connectors) (See also J, JACKS)	
P-401	41181-2	Connector, 11 Circuit Male	Power & Audio Circuit.
None	41182-2	Cap.,	For 41181-2
		Q, TRANSISTORS	
Q-301	75547-1	Transistor	Transmitter Balanced Mixer.
Q-302	75547-1	Same as Q-301	Transmitter Balanced Mixer.
Q-401	75548-3	Transistor, Power, GE PNP	DC Power Converter.
Q-402	75548-3	Same as Q-401	
		R, RESISTORS	
R-101	31192-681	Carbon, 680Ω, ±10, 1/4W	R.F. Amp. Cathode.
R-102	31141-102	Carbon, 1KΩ, ±10%, 1/2W	R.F. Amp. Screen
R-103	31192-104	Carbon, 100KΩ, ±10%, 1/4W	AVC Filter.
R-104	31141-151	Carbon, 150Ω, ±10%, 1/2W	B + Filter.
R-105	31192-104	Same as R-103	
R-106	31192-102	Carbon, 1KΩ, ±10%, 1/4W	
R-107	31141-102	Same as R-102	
R-108	31192-273	Carbon, 27KΩ, ±10%, 1/4W	
R-109	31141-151	Same as R-104	
R-110	31192-103	Carbon, 10KΩ, ±10%, 1/4W	
R-111	31192-471	Carbon, 470Ω, ±10%, 1/4W	
R-112	31192-102	Same as R-106	
R-113	31192-151	Carbon, 150Ω, ±10%, 1/4W	
R-114	31141-151	Same as R-104	
R-115	31192-221	Carbon, 220Ω, ±10%, 1/4W	
R-116	31192-474	Carbon, 470KΩ, ±10%, 1/4W	
R-117	31141-685	Carbon, 6.8 Meg, Ω, ±10%, 1/2W	AVC Delay
R-118	31192-103	Same as R-110	
R-119	31141-151	Same as R-104	
R-120	31141-151	Same as R-104	
R-121	31192-221	Carbon, 220Ω, ±10%, 1/4W	
R-122	31192-474	Same As R-116	
R-123	31192-273	Carbon, 27KΩ, ±10%, 1/4W	
R-124	31192-103	Same as R-110	
R-125	31192-105	Carbon, 1 MegΩ, ±10%, 1/4W	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		R, RESISTORS (Continued)	
R-126	31192-124	Carbon, 120KΩ, ±10%, 1/4W	
R-127	31192-105	Same as R-125	
R-128	31199-366	Metal Film, 47.5KΩ, ±1%, 1/4W	
R-129	61454-1	Potentiometer, 1 Meg.Ω, part of S-102 and S-401.....	Volume Control.
R-201	31141-223	Carbon, 22KΩ, ±10%, 1/2W	
R-202	31141-104	Carbon 100KΩ, ±10%, 1/2W	
R-203	31192-474	Same as R-116	
R-204	31192-335	Carbon, 3.3 Meg.Ω, ±10%, 1/4W	
R-205	31192-155	Carbon, 1.5 Meg.Ω, ±10%, 1/4W	
R-206	31192-104	Same as R-103	
R-207	31177-123	Met. Oxide 12KΩ, ±1%, 1/2W	
R-208	31177-103	Met. Oxide 10KΩ, ±1%, 1/2W	
R-209	31177-123	Same as R-207	
R-210	31177-103	Met. Oxide 10KΩ, ±1%, 1/2W	
R-211	31141-184	Carbon 180KΩ, ±10%, 1/2W	
R-212	31192-334	Carbon 330KΩ, ±10%, 1/4W	
R-213	31199-278	Metal Film 6.34KΩ, ±1%, 1/4W	
R-214	32045-4	Var., Wirewound 2.5KΩ	
R-215	31192-472	Carbon 4.7KΩ, ±10%, 1/4W	
R-216	31141-474	Carbon 470KΩ, ±10%, 1/2W	
R-217	31141-683	Carbon 68KΩ, ±10%, 1/2W	
R-218	31141-223	Same as R-201	
R-219	31195-105	Carbon 1 meg.,Ω, ±5%, 1/4W	
R-220	31195-105	Same as R-220	
R-221	31141-472	Carbon 4.7KΩ, ±10%, 1/2W	
R-222	31141-154	Carbon 150KΩ, ±10%, 1/2W	
R-223	31195-105	Same as R-220	
R-224	31195-105	Same as R-220	
R-225	31192-332	Carbon 3.3KΩ, ±10%, 1/4W	
R-226	32047-2	Pot 100KΩ, ±30%, 1/4W	
R-227	31199-439	Metal Film 249KΩ, ±1%, 1/4W	
R-228	31199-448	Metal Film 309KΩ, ±1%, 1/4W	
R-229	31199-422	Metal Film 165KΩ, ±1%, 1/4W	
R-230	31195-106	Carbon 10 meg.Ω, ±5%, 1/4W	
R-231	31141-124	Carbon 120KΩ, ±10%, 1/2W	
R-232	31141-913	Carbon 91KΩ, ±10%, 1/2W	
R-233	31192-105	Same as R-125	
R-234	31192-105	Same as R-125	
R-235	31192-124	Same as R-126	
R-236		Not Used	
R-237	31141-154	Carbon 150KΩ, ±10%, 1/2W	
R-238	31141-473	Carbon 47KΩ, ±10%, 1/2W	
R-239	31141-223	Same as R-201	
R-240	31141-333	Carbon 33KΩ, ±10%, 1/2W	
R-241	31141-333	Same as R-240	
R-242	31149-154	Carbon 150KΩ, ±5%, 1/2W	
R-243	31192-105	Same as R-125	
R-244	31141-681	Carbon 680Ω, ±10%, 1/2W	
R-245	31141-752	Carbon 7.5KΩ, ±10%, 1/2W	
R-246	31192-681	Same as R-101	
R-247	31199-166	Metal Film 475Ω, ±1%, 1/4W	
R-248	31199-166	Same as R-247	
R-249	31195-102	Carbon 1KΩ, ±5%, 1/4W	
R-250	31195-102	Same as R-249	
R-251	31141-103	Carbon 10KΩ, ±10%, 1/2W	
R-252	32038-3	Meter Course Selector Potentiometer 10KΩ	
R-253	31199-458	Metal Film 392KΩ, ±1%, 1/4W	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		R, RESISTORS, (Continued)	
R-301	31192-330	Carbon 33Ω, ±10%, 1/4W	
R-302	31192-473	Carbon 47KΩ, ±10%, 1/4W	
R-303	31192-683	Carbon 68KΩ, ±10%, 1/4W	
R-304	31192-101	Carbon 100Ω, ± 10%, 1/4W	
R-305	31192-101	Same as R-304	
R-306	31192-102	Same as R-106	
R-307	31192-473	Same as R-302	
R-308	31192-330	Same as R-301	
R-309	31192-223	Carbon 22KΩ, ±10%, 1/4W	
R-310	31192-473	Same as R-302	
R-311	31192-472	Same as R-215	
R-312	31192-150	Carbon 15Ω, ±10%, 1/4W	
R-313	31192-150	Same as R-312	
R-314	31192-223	Same as R-309	
R-315	31192-681	Same as R-101	
R-316	31192-101	Same as R-304	
R-317	31141-102	Same as R-102	
R-318	31192-223	Same as R-309	
R-319	31141-101	Carbon 100Ω, ±10%, 1/2W	
R-320	31141-151	Same as R-104	
R-321	31192-473	Same as R-302	
R-322	31141-101	Same as R-319	
R-323	31141-103	Same as R-251	
R-324	31141-332	Carbon 3.3KΩ, ±10%, 1/2W	
R-325	31192-102	Same as R-106	
R-326		Not Used	
R-327	31192-561	Carbon 560Ω, ±10%, 1/4W	
R-328	31192-561	Same as R-327	
R-329	31192-222	Carbon 2.2KΩ, ±10%, 1/4W	
R-330	31192-473	Same as R-302	
R-401		Not Used	
R-402		Not Used	
R-403		Not Used	
R-404	31141-102	Same as R-102	
R-405	31192-105	Same as R-125	1st Audio, Cathode.
R-406	31192-562	Carbon 5600Ω, ±10%, 1/4W	1st Audio, Plate.
R-407	31192-154	Carbon 150KΩ, ±10%, 1/4W	Fil Balance, V-5.
R-408	31135-820	Carbon 82Ω, ±10%, 1W	
R-409	31192-474	Same as R-116	
R-410	31135-471	Carbon 470Ω, ±10%, 1W	
R-411	31135-103	Carbon 10KΩ, ±10%, 1W	Audio Output Screen.
R-412	31135-472	Carbon 4.7 KΩ, ±10% 1W	
R-413	31141-331	Carbon 330 Ω, ±10%, 1/2W	B + Drop.
R-414	31162-12	Wire 1000Ω, ±5%, 5W	B + Drop.
R-415	31136-101	Wire 100Ω, ±10%, 2W	
R-416	31141-180	Wire 18Ω, ±10%, 1/2W	
R-417	31141-180	Same as R-416	
R-418	31136-331	Carbon 330Ω, ±10%, 2W	
R-419	31136-331	Same as R-418	
R-420	31141-272	Carbon 2700Ω, ±10%, 1/2W	
R-421	31192-224	Carbon 220KΩ, ±10%, 1/4W	1st Audio Screen.
R-422	31141-221	Carbon 220Ω, ±10%, 1/2W	
R-423		Not Used.	
R-424	31192-103	Same as R-110	
		S, SWITCHES	
S-101	61438-101	Switch Section	HF-IF Switching
S-102		Switch (Part of R-129 Assembly)	Ident Function.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		S, SWITCHES, (Continued)	
S-201	61445-101	Switch Section	Omni/Loc Mc/s.
S-202	61459-101	Switch Section	Omni/Loc kc/s.
S-301	61438-101	Switch Section	AVC Time Constant.
S-302	61455-101	Switch Section	Osc. Receive/ Transmit Crystals.
		T, TRANSFORMERS	
T-101	11481-1	Transformer, IF, 17.1 Mc/s	Nav HF IF
T-102	11482-1	Transformer, IF, 9.1 Mc/s	Com HF IF
T-103	11659-102	Transformer, Input, IF 4.0 Mc/s	LF IF
T-104	11657-102	Transformer, Interstage, IF 4.0 Mc/s	LF IF
T-105	11658-102	Transformer, Output, IF, 4.0 Mc/s	LF IF
T-201	11662-101	Transformer, Omni Output	Variable Phase.
T-202	11661-1	Transformer, Descriminator, 10KO	Reference Phase.
T-203	11663-101	Transformer, Audio, 30 c/s	Reference Output.
T-401		Not Used	
T-402		Not Used	
T-403	11660-101	Transformer, Audio	Modulator & Audio Output.
T-404	11670-1	Transformer, Power	DC to DC Converter.
		V, VACUUM TUBES	
V-1	None	Tube 6KE8, Receiver RF Amp. & Trans. HFO	
V-2	None	Same as V-1	Receiver First Mixer and HFO
V-3	None	Tube 6GH8A	Common LFO and Omni Limiter.
V-4	None	Same as V-3	First LF IF and Omni Var. Phase Out.
V-5	None	Same as V-1	Transmitter Buffer.
V-6	None	Same as V-3	Transmitter HFO and First Audio.
V-7	None	Tube 12AB5	Modulator and Audio Output.
V-8	None	Tube12AU7A	Omni Phase Splitter and Localizer Amplifier.
V-9	None	Same as V-3	Receiver, Second Mixer and Omni Var. Output.
V-10	None	Same as V-3	Second LF IF and Ref. Phase Output.
V-11	None	Tube 8106	Transmitter Driver.
V-12	None	Tube 7701	Transmitter Final Output.
		XT, CRYSTALS, QUARTZ FREQUENCY CONTROL	
XT-301	72020-1	Crystal, 62.7660 Mc/s 5th Mode Frequency	Rec-/Trans. Freq. Control.
XT-302	72020-2	Crystal, 63.2660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-303	72020-3	Crystal, 63.7660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-304	72020-4	Crystal, 64.2660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-305	72020-5	Crystal, 64.7660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-306	72020-6	Crystal, 65.2660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-307	72020-7	Crystal, 65.7660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-308	72020-8	Crystal, 66.2660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-309	72020-9	Crystal, 66.7660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.
XT-310	72020-10	Crystal, 67.2660 Mc/s, 5th Mode Frequency	Rec/Trans. Freq. Control.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		XT, CRYSTALS, QUARTZ (continued) Frequency Control	
XT-311	72020-11	Crystal, 67.7660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-312	72020-12	Crystal, 68.2660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-313	72020-13	Crystal, 68.7660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-314	72020-14	Crystal, 69.2660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-315	72020-15	Crystal, 69.7660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-316	72020-16	Crystal, 61.0500 Mc/s, 5th Mode Frequency	For 122.1 Mc/s.
		MISCELLANEOUS (No Symbol)	
None	41235-1	Jack, Banana	Case Ground.
None	41236-2	Plug, Banana	Chassis Ground.
None	41278-3	Lamp Holder (Subminature)	I-401, 402 and 403.
None	51625-1	Panel, Trim	Front Panel.
None	51632-1	Spring, Retainer	For Phenolic Retainer.
None	51639-1	Retainer, Phenolic	Switch & Step Inductor Retainer.
None	51640-1	Shaft, Switch	Tenths Mc/s Channel Selector.
None	51644-101	Rotor, Detent	Tenths Mc/s Channel Selector Shaft.
None	51646-1	Light Diffuser	Channel Selector Lighting.
None	51648-101	Assembly Case	Case (Cover).
None	61401-1	Roller, Detent	For Channel Selector, Tenths Mc/s.
None	61402-1	Spring, Detent	For Channel Selector, Tenths Mc/s.
None	81213-47	Spacer, Switch Shaft	Tenths Mc/s, Channel Selector.
None	81307-80	Flat Washer, Nylon	Omni Board Spacers, (3 req'd).
None	81656-11	Button, Plug	Case Latch Access Cover.
None	84079-5	Keeper	Latch.
None	88151-1	Knob	Ident. Filter Switch (S-102).
None	88152-1	Knob	Vol. Control/ON-OFF Switch, (R-129 & S-401)
None	88155-102	Dial, Course Selector	Omni Course Selector.
None	88156-101	Dial, Channel Selector	Tenths Mc/s Channels.
None	88157-101	Dial, Channel Selector	Whole Mc/s Channels.
None	88192-7	Truarc Retaining Ring	For Phenolic Retainer.



1. ALL RESISTORS ARE 1/4 WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.

Figure 7. SCHEMATIC, *narco* Mark-III, for CN-138-A

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		XT, CRYSTALS, QUARTZ (continued) Frequency Control	
XT-311	72020-11	Crystal, 67.7660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-312	72020-12	Crystal, 68.2660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-313	72020-13	Crystal, 68.7660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-314	72020-14	Crystal, 69.2660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-315	72020-15	Crystal, 69.7660 Mc/s, 5th Mode Frequency	Rec./Trans. Freq. Control.
XT-316	72020-16	Crystal, 61.0500 Mc/s, 5th Mode Frequency	For 122.1 Mc/s-
		MISCELLANEOUS (No Symbol)	
None	41235-1	Jack, Banana	Case Ground.
None	41236-2	Plug, Banana	Chassis Ground.
None	41278-3	Lamp Holder (Subminature)	I-401, 402 and 403.
None	51625-1	Panel, Trim	Front Panel.
None	51632-1	Spring, Retainer	For Phenolic Retainer.
None	51639-1	Retainer, Phenolic	Switch & Step Inductor Retainer.
None	51640-1	Shaft, Switch	Tenths Mc/s Channel Selector.
None	51644-101	Rotor, Detent	Tenths Mc/s Channel Selector Shaft.
None	51646-1	Light Diffuser	Channel Selector Lighting.
None	51648-101	Assembly Case	Case (Cover).
None	61401-1	Roller, Detent	For Channel Selector, Tenths Mc/s.
None	61402-1	Spring, Detent	For Channel Selector, Tenths Mc/s.
None	81213-47	Spacer, Switch Shaft	Tenths Mc/s, Channel Selector.
None	81307-80	Flat Washer, Nylon	Omni Board Spacers, (3 req'd).
None	81656-11	Button, Plug	Case Latch Access Cover.
None	84079-5	Keeper	Latch.
None	88151-1	Knob	Ident. Filter Switch (S-102).
None	88152-1	Knob	Vol. Control/ON-OFF Switch, (R-129 & S-401)
None	88155-102	Dial, Course Selector	Omni Course Selector.
None	88156-101	Dial, Channel Selector	Tenths Mc/s Channels.
None	88157-101	Dial, Channel Selector	Whole Mc/s Channels.
None	88192-7	Truarc Retaining Ring	For Phenolic Retainer.

SECTION 8
SCHEMATICS

8-A. INTRODUCTION.

The schematics are in the form of a two-page pullout sheet which can be used while the pages of the text, illustrations, or parts list are open for use.

The schematic diagrams are provided in duplicate, with the following variations:

1. The first diagram is printed in BLACK, without test data.
2. The second diagram is printed in GREY, with test data in a RED overprint.

This arrangement was adopted in order to provide a maximum of information in a convenient form.

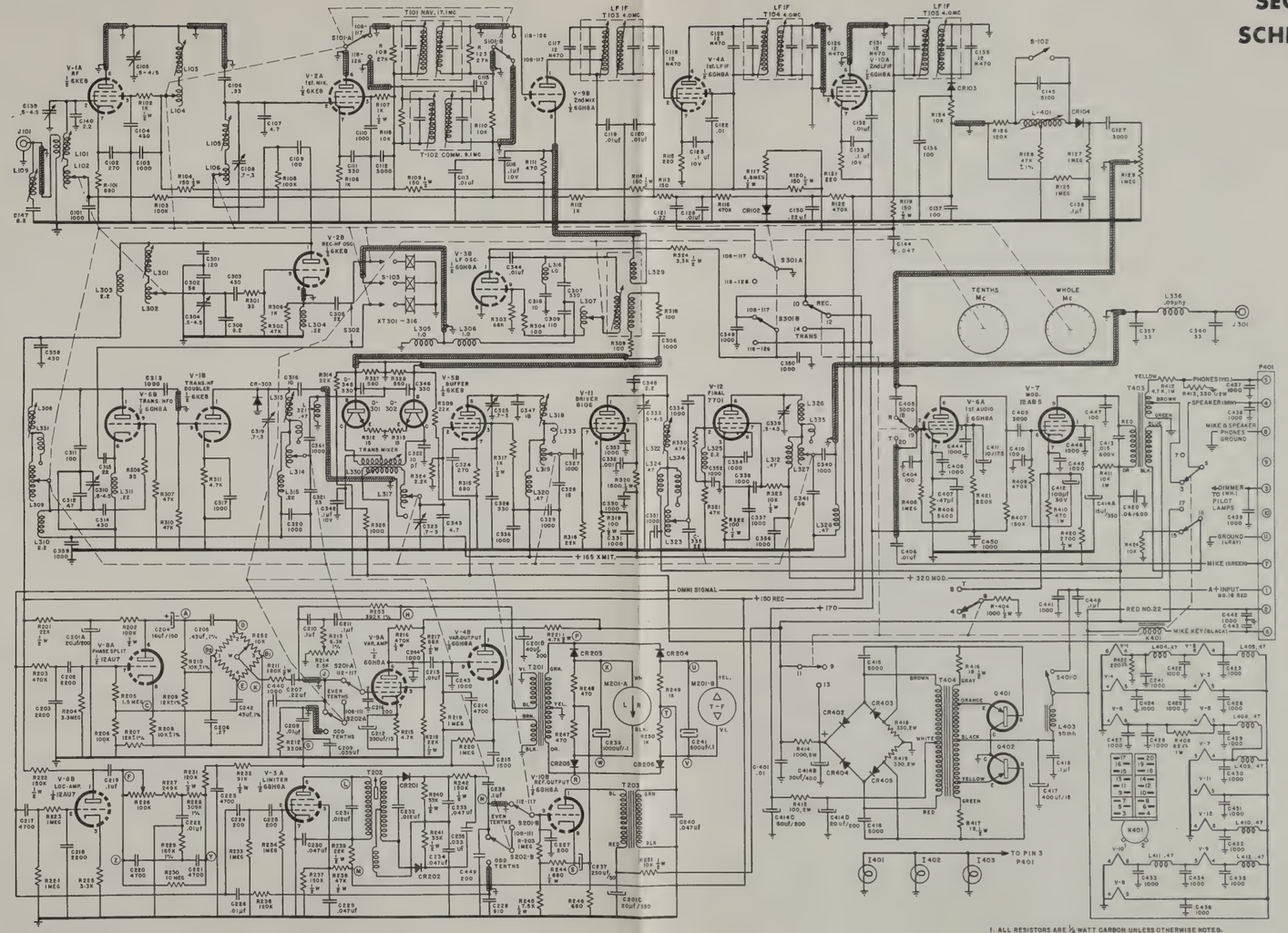
The BLACK print shows all the circuits and components in the Panel Unit, with the usual symbols and values.

The GREY print with the RED overprint provides information for alignment and test purposes. When difficulty is encountered in reading symbols or circuit values in GREY, because of the RED overprint, reference may be made to the BLACK print which is identical with the GREY.

8-B. SCHEMATIC DIAGRAMS.

Figure 7. Schematic.

Figure 8. Schematic with Test Data Overprint.



1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.

Ref. R-02207-J ECN-4676 9-27-65

Figure 7. SCHEMATIC, *narco* Mark-III, for CN-138-A

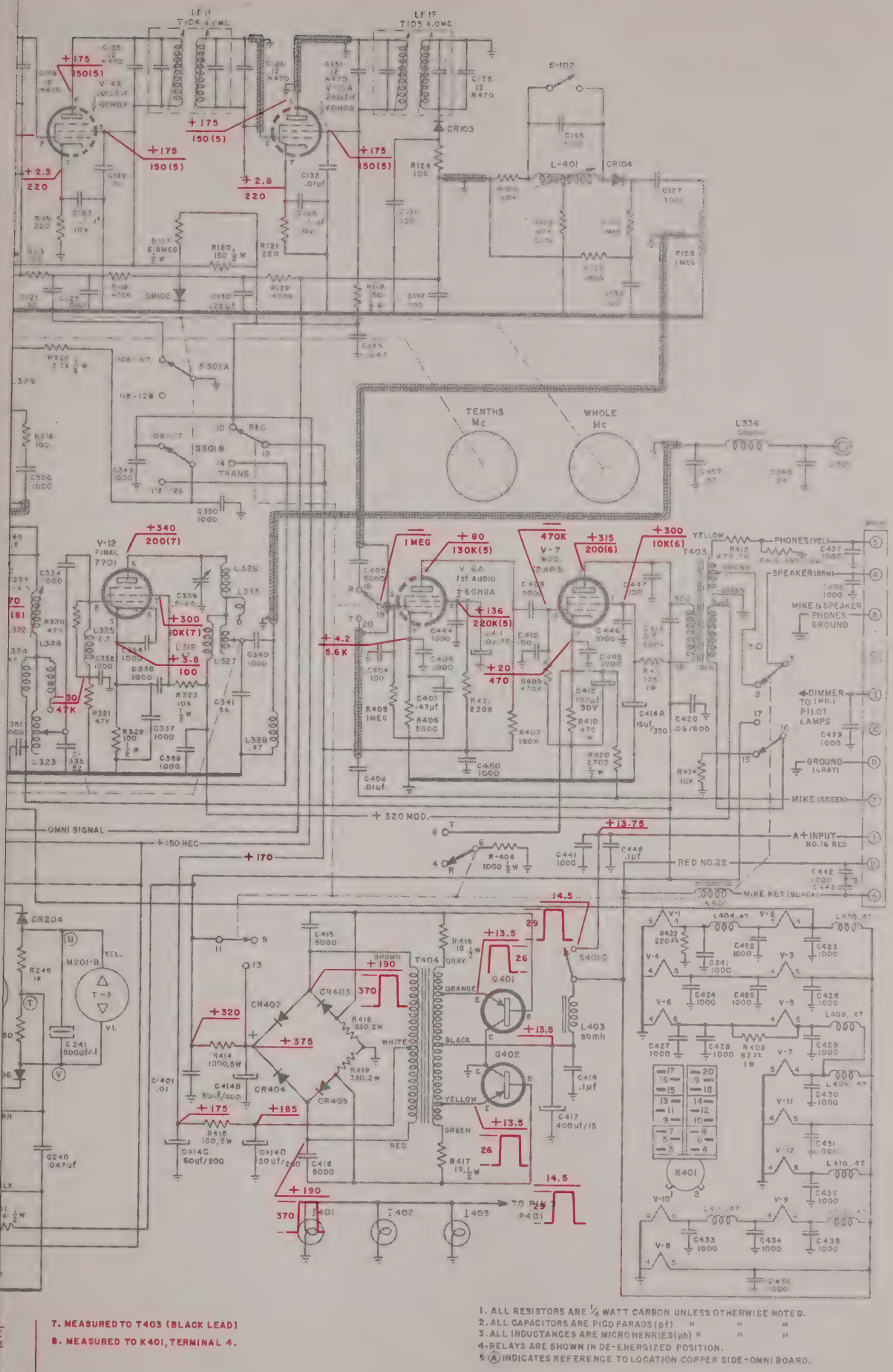
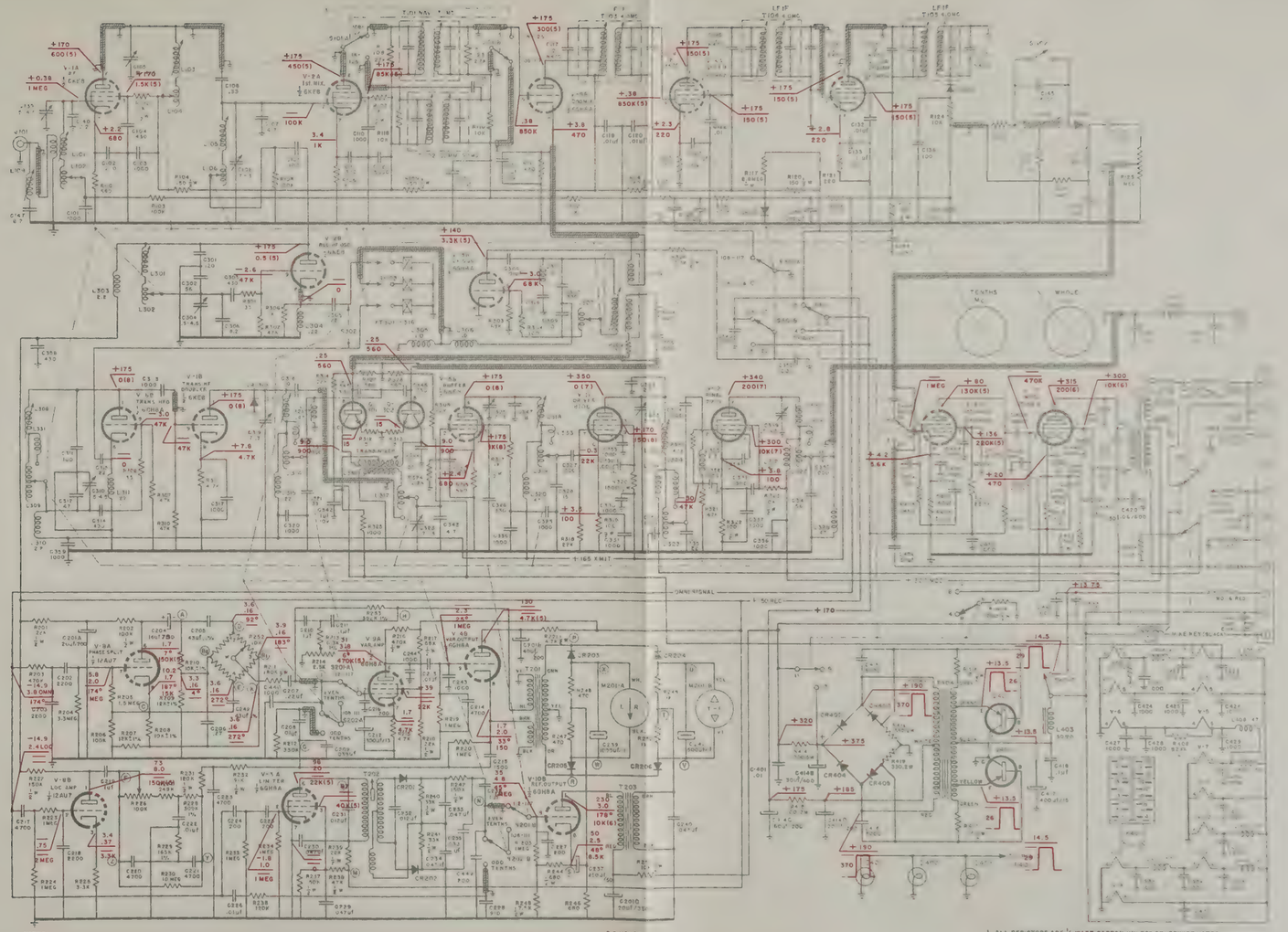


Figure 8. SCHEMATIC with TEST DATA, Overprint, ***narco*** Mark-III, for CN-138-A

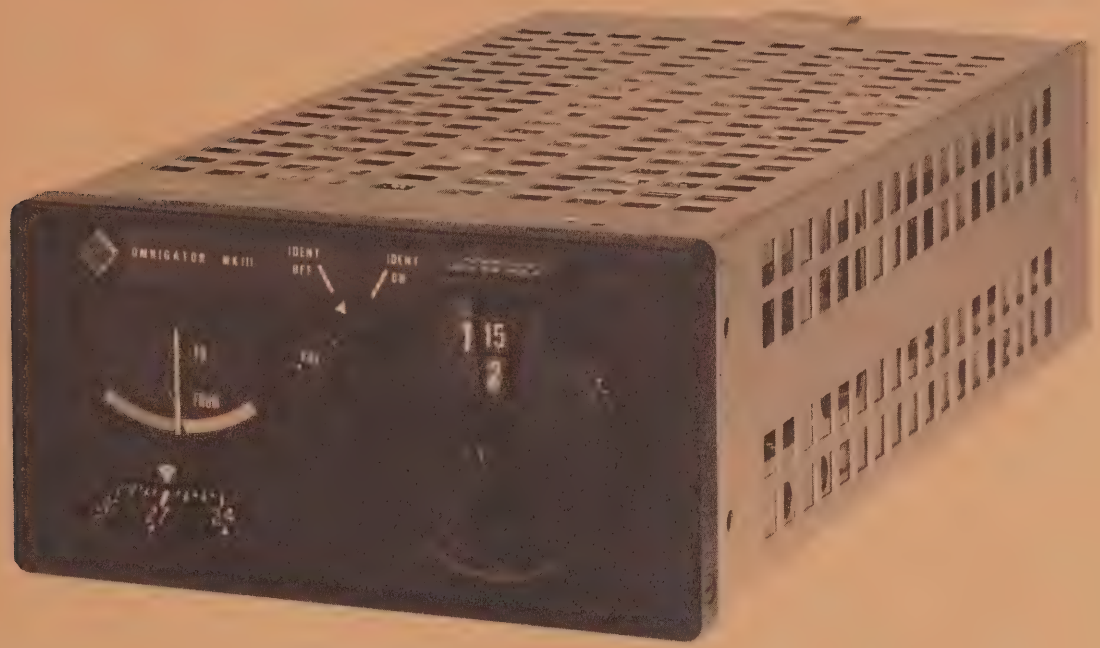

NOTES:
1. ALL VOLTAGES, RESISTANCES AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE NOTED.
2. ALL RECEIVER VOLTAGE MEASURED WITH VOLUME CONTROL FULL CCW, NO SIGNAL INPUT AND 13.75 V.DC APPLIED TO UNIT.
3. ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75V.DC APPLIED TO UNIT.
DC VOLTS
RESISTANCE
4. ALL OMNI VOLTAGES MEASURED WITH 13.75 V.DC APPLIED TO UNIT, COURSE SELECTOR AT 0°, 500 µv. OMNI SIGNAL APPLIED.
5. MEASURED TO C414, SECTION "C".
6. MEASURED TO C401.
DC VOLTS
AC VOLTS
PHASE ANGLE
RESISTANCE
7. MEASURED TO T403 (BLACK LEAD)
8. MEASURED TO R401, TERMINAL 4.
1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICROHENRIES (µh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.

Ref. R-02207-J ECN-4676 9-27-65

Figure 8. SCHEMATIC with TEST DATA, Overprint, ***narco*** Mark-III, for CN-138-A

OMNIGATOR MARK III

NOTE—This sheet may be placed at the front of the original Manual MM-220, (now 3076-600).



MAINTENANCE MANUAL

for

CN-138-A and CN-138-B

Mark III Equipment

for

VHF Communication

and

OMNI Navigation

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON. PENNSYLVANIA, 19034 U.S.A.

3076-600 (was MM—220)
with
Supplement No. 1

Printed in U.S.A.

May, 1966

OMNIGATOR MARK III

SUPPLEMENT No. 1
to
MAINTENANCE MANUAL
for
CN-138-A and CN-138-B

Mark III Equipment
for
VHF Communication
and
OMNI Navigation

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NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON. PENNSYLVANIA, 19034 U.S.A.

3076-600(was MM—220)
Supplement No. 1

Printed in U.S.A.

May, 1966

INTRODUCTION.

This is supplement No. 1 to the original Maintenance Manuel MM-220 (now 3076-600) issued September 1965.

It is concerned primarily with equipments having chassis number CN-138-B. However, detailed information is provided to cover all variations since the original manual was issued. A new schematic diagram is provided.

Provision has been made to substitute several other frequencies for the 122.1 Mc/s "Navigation Transmitter Frequency" normally supplied.

A second cooling kit (Right Angle Type) has been made available.

A D.C. Converter Kit is available for installations having a power transistor failure problem, due to excessive heat or inadequate cooling.

Some of the Transmitter Adjustment procedures have been revised.

OMNI Circuit information has been revised and OMNI compensation procedure has been expanded with the addition of a diagram and a table.

Several revised photos are provided to show where significant changes or corrections have been made.

Additions to the replacement parts list are given, to accommodate the various changes.

For details concerning the above items see the list of "CONTENTS" on the preceding sheet, page 55, and the information on pages 57 thru 73 herewith.

NOTE—Any page references below page 55 are in the original manual MM-220 (now 3076-600). Pages 55 etc., are contained in this supplement.

CORRECTIONS.

References are to pages in the original Manual MM-220 (now 3076-600).

Page 9.
Under 2.D. OPTIONAL ACCESSORIES.
Item 5. KIT COOLING., note that the ***narco*** Part No. is now EL-3076-500, instead of EL-2096 (see also under ADDITIONS, this page).

Page 24.
Under 5-G,7. Final Amplifier., in second line read –35 VDC instead of –45 VDC (See also page 60 in this supplement).

Page 35.
Photo C. Note that the symbols for V-11 and V-7 have been interchanged. V-7 is nearest the right hand side. (See also Photo Ca., page 65, in this supplement.)

Page 36.
Photo D. Note that the symbol C-301 along the left side should read C-304 (See also Photo Da., page 66, in this supplement).

Pages 49 and 50.
The exact crystal frequencies for XT-301 thru XT-316 should correspond with the frequencies given in the tables I and II, on page 29 and 30, rather than the approximate frequencies given on pages 49 and 50. (See also page 69 in this supplement.)

Page 50.
Under MISCELLANEOUS (No Symbol)
narco

Part No.	*Description*
84079-5	Keeper. Correct part no. is 84097-5.
88192-7	Truarc Retaining Ring. Correct part No. is 81192-7.

ADDITIONS.

Page 7.
Under 1-A. INTRODUCTION.
Add the following statement to the third paragraph.
"The 122.1 Mc/s transmitter channel normally available whenever the channel selector is set to a navigation frequency, may be changed for special purposes. The alternate frequencies available are 122.4, 122.5, 122.6, 122.7 Mc/s."

Page 9,
Under 2-D OPTIONAL ACCESSORIES.
Add the following three items:

6. KIT, COOLING, Right Angle Type, ***narco*** Item No. EL-3076-501.
7. KIT, MODIFICATION, D.C. Converter. ***narco*** Item No. 3076-602.
8. KIT, FREQUENCY Change, Navigation Transmitter. ***narco*** Item No. EL-3076-503. (See introductory paragraph above for available frequencies).

Pages 23, 24, 25, 26
The two sheets having the above four pages numbers are being reprinted as pages 69, 70, 71 and 72 in this supplement.

The following paragraphs are affected:
5-G,1. Two sentences have been added.
5-G,7. Second line read –35 VDC instead of –45 VDC.
5-G,8. This is a new subsection replacing 5-G8 Modulator.
5G,9. This is a new subsection.
5G,10. This is the Modulator subsection which was 5-G,8.
5-H,2. Has been completely re-written.
5-H,3. Has been completely re-written.
A diagram and a table have been added to assist in proper OMNI compensation. See page 62.

Pages 35, 36, , 38, 39.

New photos have been provided for Photos C, D, ——, G, H. They are printed as Ca, Da, Ga, Ha on pages 65, 66, 67, 68 in this supplement.

NOTE—In this supplement, page 63 contains a list of production changes, itemized by chassis numbers.

Pages 41 thru 50.

The changes and additions in part numbers are contained in the list appearing on page 69.

Pages 51 and 53.

The schematic and test data diagrams have been redrawn. They are printed in this supplement as Figures 7a., and 8a., on pages 71 and 73 Extensions.

5-G. TRANSMITTER ADJUSTMENT PROCEDURES.

5-G,1,a. High Frequency Oscillator (HFO).

With the equipment connected as shown in the Transmitter Test Setup Diagram, Figure 5, page 32 refer to the Schematic Diagram, Figure 7, page 51. The drive at the grid of V-6B, Pine 9, should be –3.0 V.dc minimum on all COM Mc/s channels. If it is less, select 126 Mc/s and peak L-308 for maximum voltage. Then, select 118 Mc/s and peak C-310 for maximum voltage. Repeat this procedure until the drive is approximately flat over all Mc/s channels. Rotate the channel selector to any navigation frequency (108.0 thru 117.9 Mc/s). Activate the transmitter, and observe oscillator grid drive. If no drive voltage is present, or is very low, adjust the small airwound coil L-331 by compressing or spreading the turns until maximum drive voltage is obtained.

5-G,2. High Frequency (HF) Doubler.

The rf voltage at the grid of the H.F. Doubler should be approximately 3 volts RMS. It may be measured with the DC VTVM and its Diode Probe.

5-G,3. Low Frequency Oscillator (LFO).

The drive at the grid of V-3B should be at least –3.0 V. dc measured through a 1 megohm resistor in series with the VTVM. If it is less, Select the 0.0 Kc/s channel and peak L-329 for maximum negative voltage. The remaining tenths Mc/s positions 0.1 thru 0.9 should then all be in tune.

5-G,4. Balanced Mixer

The Balanced Mixer involving Q-301 and Q-302 receives energy from both the transmitter HF Doubler, V-1B, and the common LFO, V-3B. Energy levels from the HF Doubler and LFO are quite low. They can be measured with the DC VTVM and its Diode Probe.

a. To measure the level from the LFO deactivate the HF Doubler by removing the tube V-6. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.15 volt RMS.

   If the voltage is too low the adjustment of L-313 should be peaked at 126.5 Mc/s and C-319 should be peaked at 118.5 Mc/s. She Photo D, page 36. These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

   Replace V-6 as soon as the measurement is completed.

b. To measure the level from the HF Doubler deactivate the LFO by removing the tube V-3. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.25 Volt RMS. Replace V-3 as soon as the measurement is completed.

c. The combined voltages from the LFO and the HF Doubler at the bases of Q-301 and Q-302 should be alike and approximately 0.5 Volt RMS.

5-G,5. Buffer.

The buffer stage, V-5B, receives its grid drive from the output of the Balanced Mixer, Q-301 and Q-302. This drive is at the desired transmitter output frequency, but at a low level. It may be measured with the DC VTVM and its Diode Probe, at terminal 2 of V-5B. The voltage should be about 1.0 Volt RMS.
If the voltage is too low L-330 should be peaked at 126.5 Mc/s and C-323 at 118.5 Mc/s. See Photo D. These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

NOTE: Allowance should be made for some loading effect of the probe connection. This may be done by re-checking the peaking with the probe connection on the Driver grid (V-11, terminal 7).

5-G,6. Driver.

The voltage at the grid of the driver, V-11, pin 7, should be –0.3 V. dc minimum. If it is less, proceed as follows:

1. Select the 0.5 Mc/s position on the tenths Mc/s Selector.
2. Select the 126 Mc/s position on the Mc/s Selector and peak L-313, L-330, and L-318 for maximum negative volts at Pin 7 of V-11 (through a 1 megohm resistor).
3. Select the 118 Mc/s position on the Mc/s Selector and peak C-319, 323 and C-325 for maximum negative volts at Pin 7, V-11.
4. Repeat the above procedure until the drive is approximately flat across all Mc/s channels.

➟ Indicates a change.

Reference page 23, in original Manual

5-G,7a. Final Amplifier.

The drive at junction of L-325, R-321, R-330, and C-352 should be at least –35 VDC. If it is less, select the 126 Mc/s channel and peak L-322 for maximum negative volts at the junction of the above components. Then, select the 118 Mc/s channel and peak C-333 for maximum negative volts. Repeat the procedure until the drive is approximately flat across all Mc/s channels.

5-G,8. Navigation Transmitter Alignment.

After the transmitter is completely aligned, rotate the channel selector to a navigation channel. Continue to monitor the final grid drive as in 5-G,7. If the drive is low or non-existent, adjust airwound coils L-332, L-333, L-334, and L-335 in the order listed to obtain proper drive at the amplifier. These small coils will be found connected across the bottom of the transmitter step inductors.

Rotating the channel selector through all the navigation channels should produce a power output which is equal to or slightly greater than the output power obtained through the communications band (118.0 thru 126.9 Mc/s).

5-G,9. Transmitter In-Case Alignment.

Before installing the unit in the aircraft, the transmitter tuning should be readjusted with the unit in a case, or the equivalent of the lower half of the case. This is necessary due to the proximity of the case to the transmitter circuits. The bottom of the case, or its equivalent, should be modified with a small access hole over each of the transmitter coils. The transmitter should be checked over all channels to insure proper operation. The unit may then be removed from the tune-up case and placed in the aircraft.

5-G,10. Modulator.

The transmitter final output amplifier V-12, a type 7701 tube, is modulated by the common Audio Amplifier tube, V-7, via a winding on the output of the transformer T-403.

The audio voice signal from the microphone goes via C-406 to the grid of the first audio stage, V-6A, terminal 2. The level at this point should be about 0.25 volts audio. The level at the grid of V-12, terminal 6, should be about 15 volts audio.

With the above condition the audio level across the RED and ORANGE primary leads on T-403 should be about 150 volts. This represents approximately 5 watts of audio modulation power.

5-H. OMNI CIRCUITS.

5-H,1. Reference Channel Alignment.

To Check the Omni Reference Channel Alignment proceed as follows:

a. Connect the test equipment to the receiver as described under 5-E, Above.
b. Connect an oscilloscope to Pin 9 of V-10B.
c. Locate the discriminator transformer T-202. Adjust the primary and secondary cores for maximum undistorted signal as noted on the scope. If, in the process of peaking the primary and secondary slugs, the TO-FROM flag changes direction, you have tuned on a false peak. Look for another peak which will give maximum amplitude without causing the TO-FROM flag to change direction. This is the proper setting.

5-H,2a. Variable Phase Alignment.

a. Set the Mark-III course selector dial and the OMNI signal generator to 270°. Set the LEFT-RIGHT indicator to 0 with the OMNI 0 set control (R-214).
b. Set the Mark-III course selector and the OMNI signal generator to 90° and note reading. If an error exists, compensate across R-208 or R-210 for 180° phase shift between 90° and 270°. Then with the signal generator and course selector 270°, re-center the L-R meter.
c. Set the Mark-III course selector and the OMNI signal generator to 0° and check for error. Now reset course selector and OMNI generator to 180° and check for error. If necessary, compensate across R-207 or R-209 for 180° phase shift between 0° and 180°. If absolute error is greater than 0.5° compensate C-206 for 90° quadrature between 0° - 180° and 90° - 270°. See the diagram and table on page 62.

5-H,3a. Rectifier Balance.

(See photo G-a., page 67)

a. Set the course selector dial and the OMNI signal generator to 270°. Center the LEFT-RIGHT indicator with the OMNI 0 set control R-214. Then set the OMNI signal generator to 90° and note any error present. This error represents reciprocal error. Before compensating this error, the error at 90° should be checked. This is necessary because the reciprocal error at 90° may not be of the same magnitude as that seen at 270°.
b. With the OMNI signal generator set at 90°, adjust the course selector dial to center the L-R needle at 90°. Now reset the generator to 270° and note the reciprocal error, which should not exceed ± 3°.
c. If the error is greater than ± 3° compensate across R-247 or R-248 for minimum reciprocal error at both the 90° and 270° course selector settings.

5-H,4. Localizer Centering Adjustment.

a. Set the receiver to a proper Localizer channel and properly set up the OMNI Signal Generator for a Localizer Signal. Refer to 5-E,3., page 22.
b. The only compensation available for centering the Left-Right Indicator is the adjustment marked "LOC," See Photo E, Page 37. Turn this adjustment (R-226) to center the needle.

5-1. PRINTED CIRCUIT METHODS.

Printed circuits are very reliable and serviceable when they are properly designed, installed and maintained. However, they may be easily damaged by improper maintenance procedures. The following methods if carefully observed will insure satisfactory repairs.

Indicates a change.

Reference page 23, in original Manual

5-I,1. Tools Required.

a. Soldering Iron, small, 40 watts or less.

b. Small Long Nose Pliers.

c. Small Angle Cutters.

d. Small Stiff Bristle Brush, or "Solder Sipper."

e. Sharp pointed instrument (scriber).

CAUTION:

NEVER place the soldering iron directly on the printed circuit if it can be avoided. EXCESSIVE HEAT will raise the circuit from the board.

5-I,2. Replacement of Small Components.

a. Cut the leads and remove the component from the board.

b. Using the small soldering iron and long nose pliers, lift the remaining ends of the component from the board.

c. With the tip of the iron open the holes in the board by drawing the solder away from the holes.

d. Bend the leads of the replacement component and fit them through the holes observing polarity), if any.

e. Cut off any excess lead length.

f. Observe that contact surfaces are clean, then resolder.

5-I,3. Replacement of Transistors and Crystals.

a. Heat the leads one at a time and remove the solder with a stiff brush or a "solder sipper."

b. Remove the transistor or crystal by pulling and rocking it gently, while touching the leads with the soldering iron if necessary.

c. Clear the holes of solder and insert the replacement, orienting the connection properly.

d. Observe that contact surfaces are clean then resolder.

CAUTION

Transistors and Crystals may be damaged by over-heating. Use the minimum heat that will still permit rapid removal or replacement.

5-I,4. Replacement of Large Components.

a. Heat each joint enough to soften the solder and using the stiff brush, or "solder sipper," remove the solder. Do only one joint at a time, or only as large an area as will require a minimum of heat.

b. GENTLY pull the defective part from the board when all joints have been cleared.

c. Clear the holes and insert the replacement component, orienting correctly.

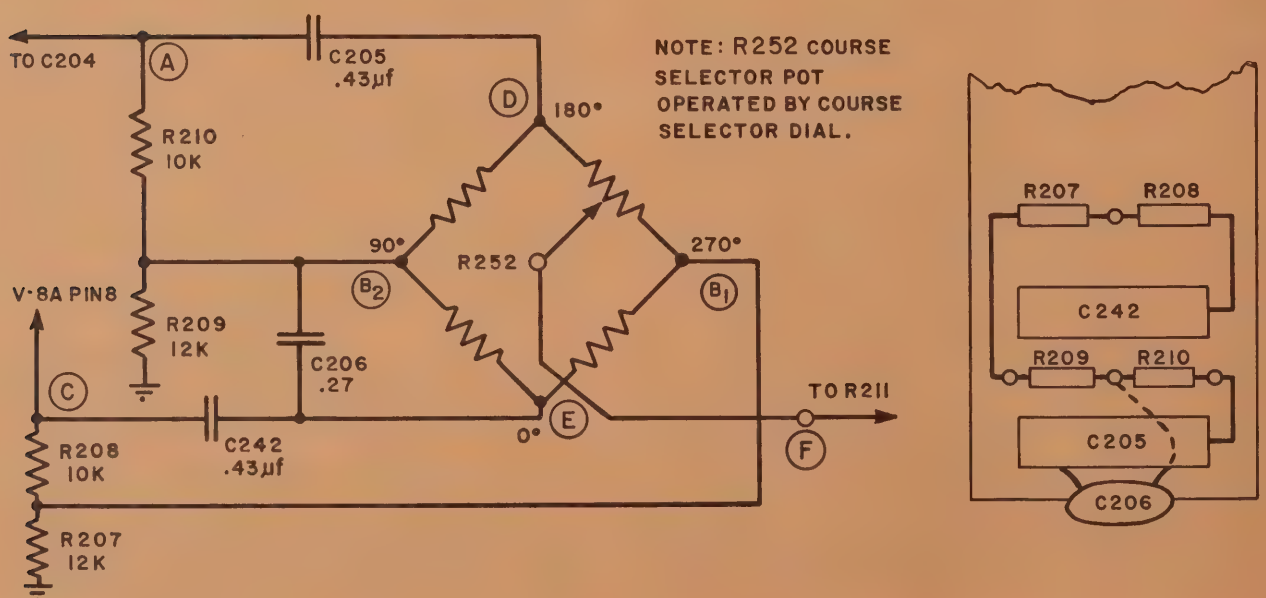
d. Observe that contact surfaces are clean then resolder.

NOTE—The brushing, or "solder sipping" method described under a. above may be used to remove any component where it is undesirable or impossible to cut the leads.

Reference page 25, in original Manual

OMNI COMPENSATION TABLE
(TYPICAL)

COMPENSATION	COURSE SELECTOR DIAL SETTING	EFFECT ON COURSE SEL. DIAL SETTING
68K OHMS across R-210	0°	1.7° NEGATIVE
68K OHMS across R-210	180°	NONE
68K OHMS across R-210	270°	2.2° NEGATIVE
68K OHMS across R-210	90°	0.7° POSITIVE
68K OHMS across R-209	0°	4.0° POSITIVE
68K OHMS across R-209	180°	4.0° NEGATIVE
68K OHMS across R-209	270°	0.2° POSITIVE
68K OHMS across R-209	90°	NONE
68 K OHMS across R-208	0°	1.2° POSITIVE
68 K OHMS across R-208	180°	0.3° NEGATIVE
68 K OHMS across R-208	270°	2.0° POSITIVE
68 K OHMS across R-208	90°	1.0° NEGATIVE
68K OHMS across R-207	0°	4.0° NEGATIVE
68K OHMS across R-207	180°	4.0° POSITIVE
68K OHMS across R-207	270°	0.5° NEGATIVE
68K OHMS across R-207	90°	0.5° POSITIVE
0.03μF across C-206	0°	NONE
0.03μF across C-206	180°	NONE
0.03μF across C-206	270°	0.6° POSITIVE
0.03μF across C-206	90°	0.6° POSITIVE



PRODUCTION CHANGES.

NOTE—The Schematic in the original MM-220 (now 3076-600), September 1965, represents chassis No. CN138-A7. The Schematic in this supplement represents CN138-B5.

CN138-A1

A shield and grounding clip were added adjacent to the V-7 tube socket. A capacitor, C-337, was connected between Pins 3 and 4 of the V-12 tube socket. Capacitor C-338 was connected between Pins 3 and 7 of the V-12 tube socket. This was done to improve neutralization.

CN138-A2

Resistor R-236 (820 ohms) was deleted from the junction of C-342 and R-325. The value of R-325 was changed from 330K ohms to 1K ohms. This was done to improve mixer voltage regulation.

CN138-A3

Capacitor C-322 (10pF) was added to improve the transmitter mixer balance.

CN138-A4

Relay terminal No. 15 had been directly grounded. The resistor R-424 (10K ohms) was added between terminal 15 and the grounded shell of J-101 on the back panel. This was done to improve audio output response.

CN138-A5

The headphone and speaker circuits were rewired to prevent speaker squeal during transmit. The resistor R-412 was changed from 2.2K ohms to 4.7K ohms. The resistor R-413 was changed from 68 ohms to 330 ohms. The resistor R-423 (68 ohms) which was connected between speaker lead (brown) and ground is now deleted.

CN138-A6

The LFO trap consisting of L-316 and C-138 is connected between the junction of C-344, C-307, L-329, and the grounded shield. This was done to improve the sensitivity at 117.9 Mc/s.

CN138-A7

The lead dress of buss wires on the L-327 (Final Step Inductor) was changed. This was done to reduce final output tracking problems.

CN138-A8

The value of L-306 in the LFO was changed from 1.0 μH to 0.68 μH for better LFO injection. A 15 pF capacitor was added across C-117, which in turn is across the primary of T-103. This was done to improve LFIF bandwidth.

CN138-A9

The length of the coax cable between C-313 and Pin 9 of V-1B was shortened 1 inch. This was done to improve HF Doubler stability.

CN138-A10

The audio output transformer, T-403 was provided with a metal shield to prevent audio squeal at high volume levels. The resistor R-213 at the OMNI 0 Set Pot was changed from 6.3K ohms to 8.25K chms for easier compensation of the OMNI circuits.

CN138-A11

In the grid circuit of V-4B, C-214 capacitor which was .0047 μF, was changed to .0082 μF. The resistor R-219, 1 megohm, was changed to 560K ohms. This was done to improve LOC stability. Relocating the wiring to C-401 and C-414B eliminated the need for C-240.

CN138-A12

The Diode CR-304 was added between the center tap of L-330 and the junction of C-345 and C-346. This was done to prevent transistor failure due to transients.

CN138-B

The DC to DC converter circuit was modified to improve reliability under high temperature conditions.
Fuse, F-401 was added .
Capacitors C-401 and C-402 were added.
Resistors R-416 and R-417 were changed.
Capacitors C-415 and C-416 were changed.

CN138-B1

Resistor R-215 in the cathode circuit of V-9A was 4.7K ohms. It was changed to 5.6K ohms, to improve OMNI compensation. The capacitor C-222 in the plate circuit of V-8B was 0.01 μF. It was changed to 0.12 μF, to improve the ease of LOC centering.

CN138-B2

In the receiver HFO, C-304 was deleted and replaced by C-362 in a new location. In the transmitter HFO, C-310 was deleted and replaced by C-363 in a new location.
These two changes were made to improve oscillator stability and tracking.

CN138-B3

In the Transmitter Buffer V-5B circuit the resistor R-324 was changed from 2.2K to 47K, to improve the drive to the final R.F. amplifier, V-12.

CN138-B4

In the R-252 course selector circuit, the capacitor C-206 was changed from 0.22 μF to 0.27 μF to improve bridge balance.

CN138-B5

In the transmitter mixer circuit the capacitor C-342 was changed from 0.1μF to .001μF and was relocated. It is now connected between the L-330 center tap terminal and ground. The ground connection is to the point which grounds two coax cables and one side of the resistors R-327 and R-328. The ground for resistor R-313 is also relocated. It is connected to the same ground point as C-342.
This change was made to reduce spurious responses in the transmitter mixer circuit.

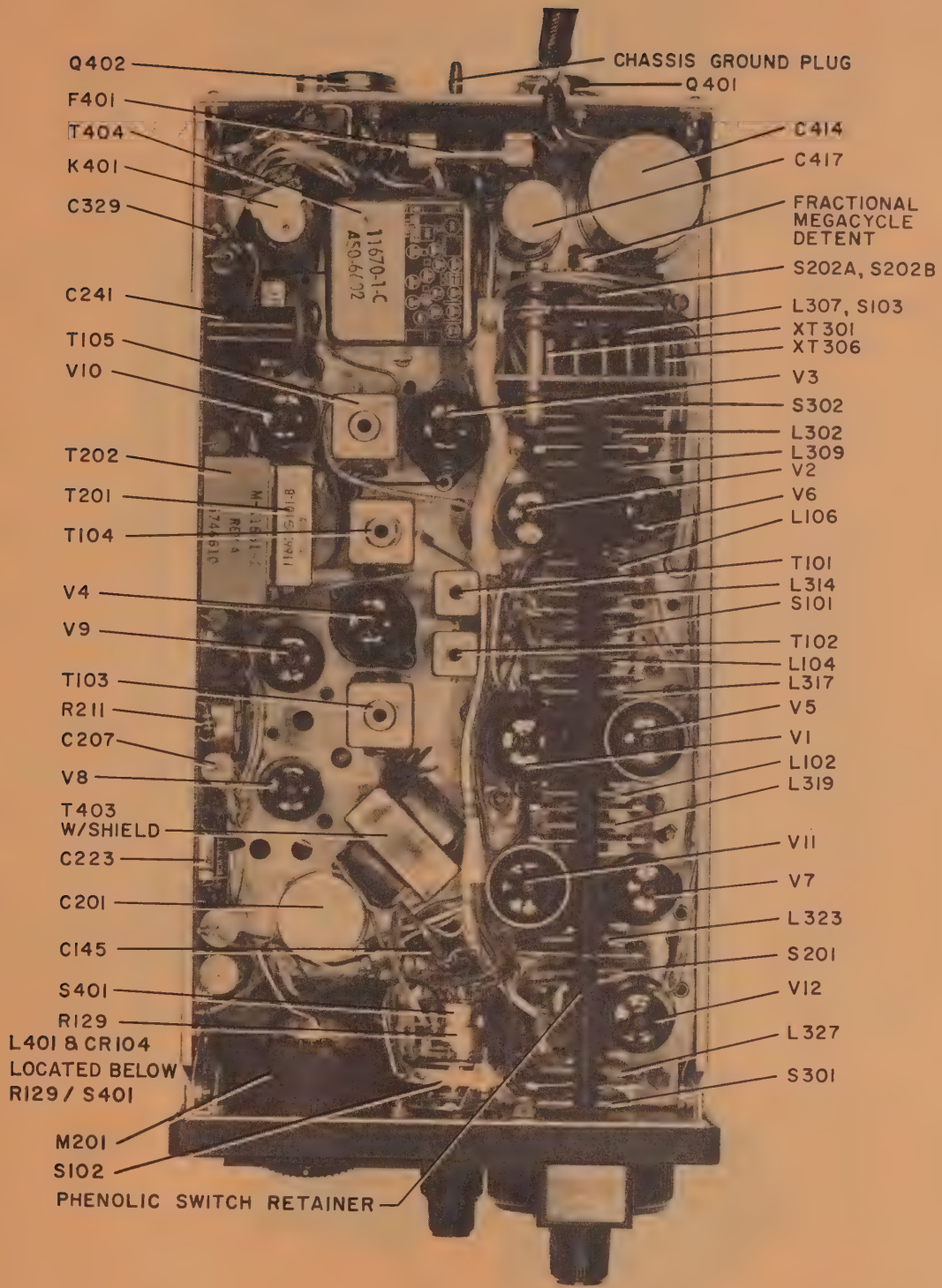


Photo Ca.
TOP VIEW, ***narco*** Mark-III Equipment.

Reference page 35, in original Manual

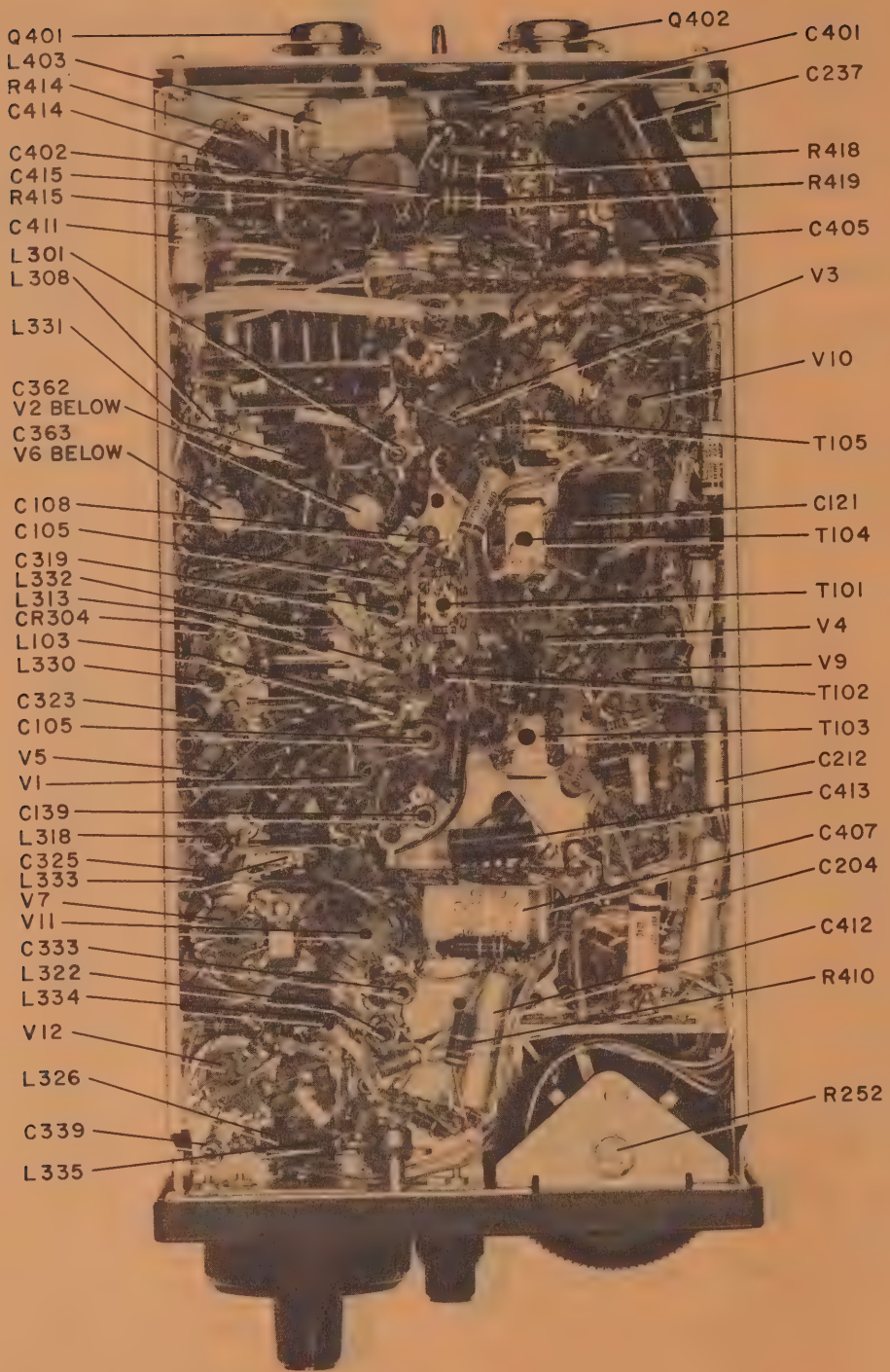


Photo Da.
BOTTOM VIEW, *narco* Mark-III Equipment.

Reference page 36, in original Manual

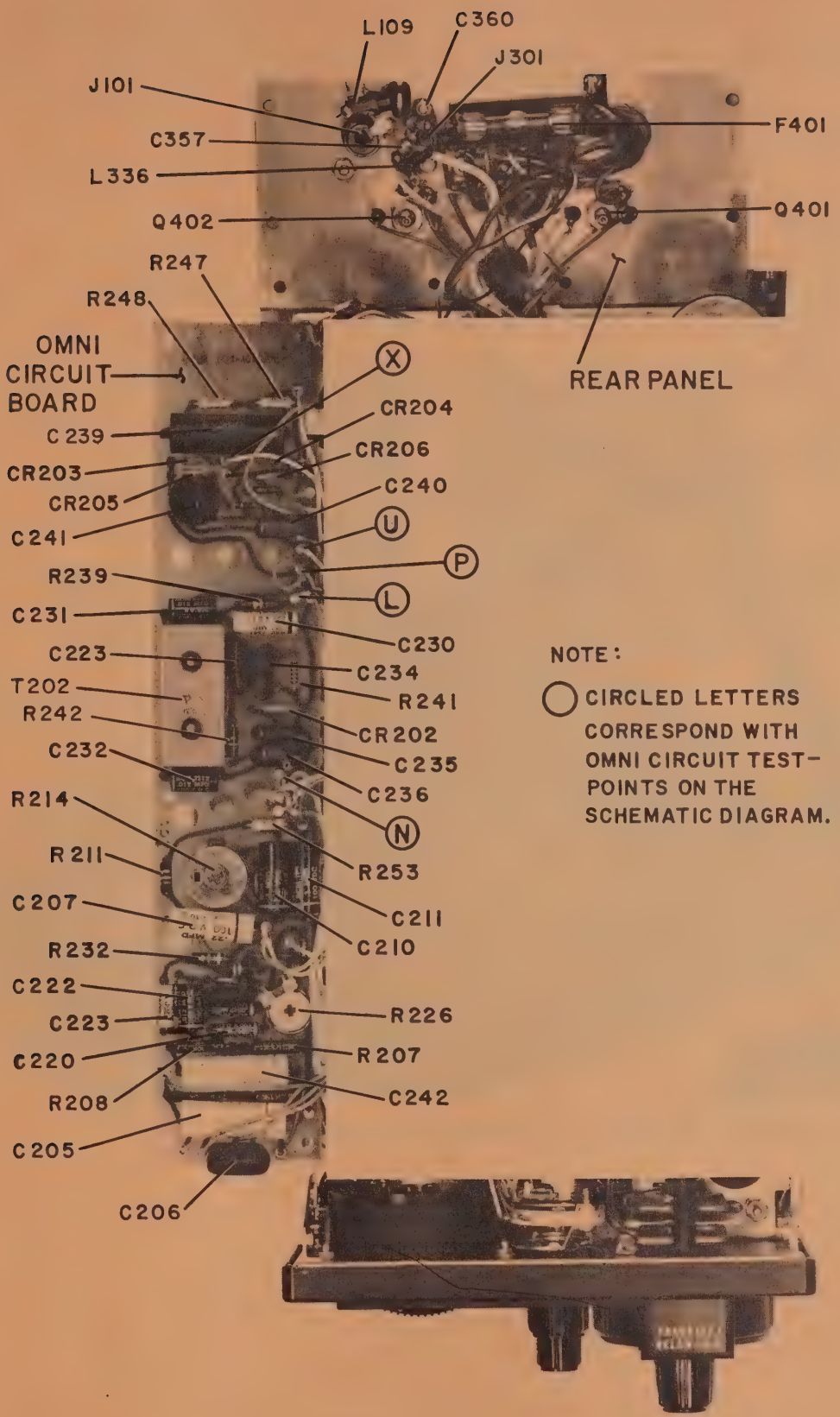


Photo Ga.
OMNI BOARD (Component Side), and REAR PANEL
narco Mark-III Equipment.

Reference page 38, in original Manual

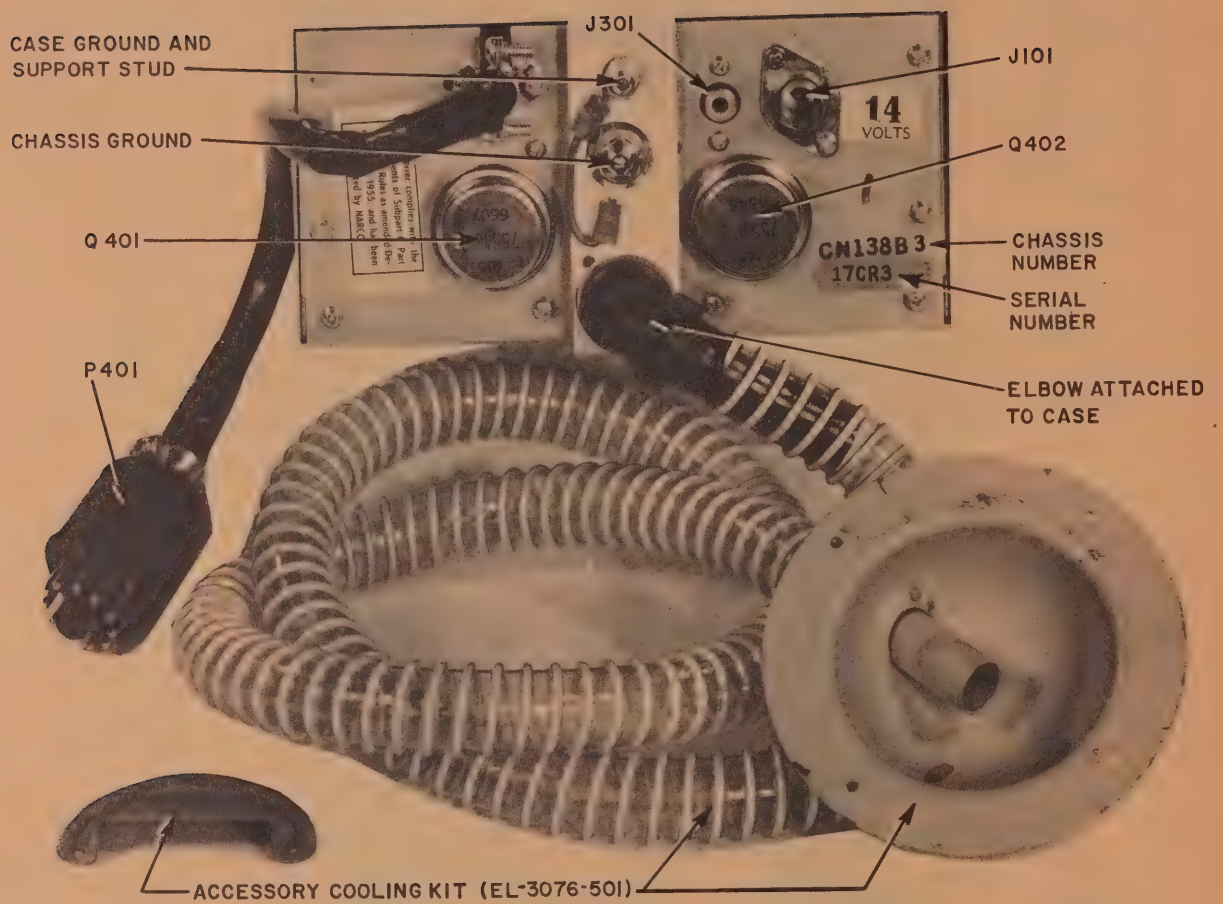


Photo Ha.
REAR VIEW, with CASE and COOLING KIT.
narco Mark-III Equipment.

Reference page 39, in original Manual

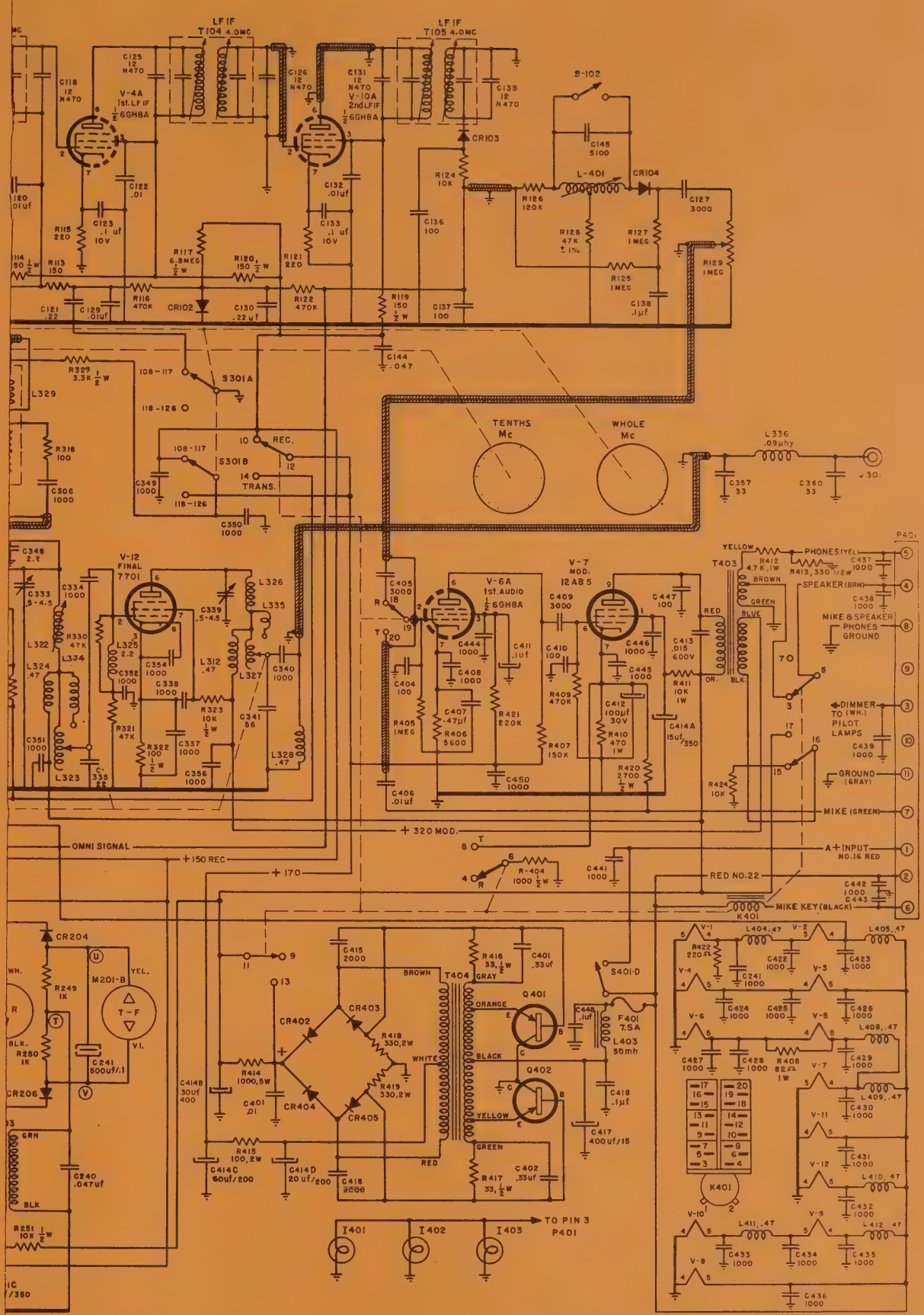
REPLACEMENT PARTS.

This list contains the revised items corresponding with the various chassis changes.

Also included is a list of the available alternate "navigation transmitter frequencies."

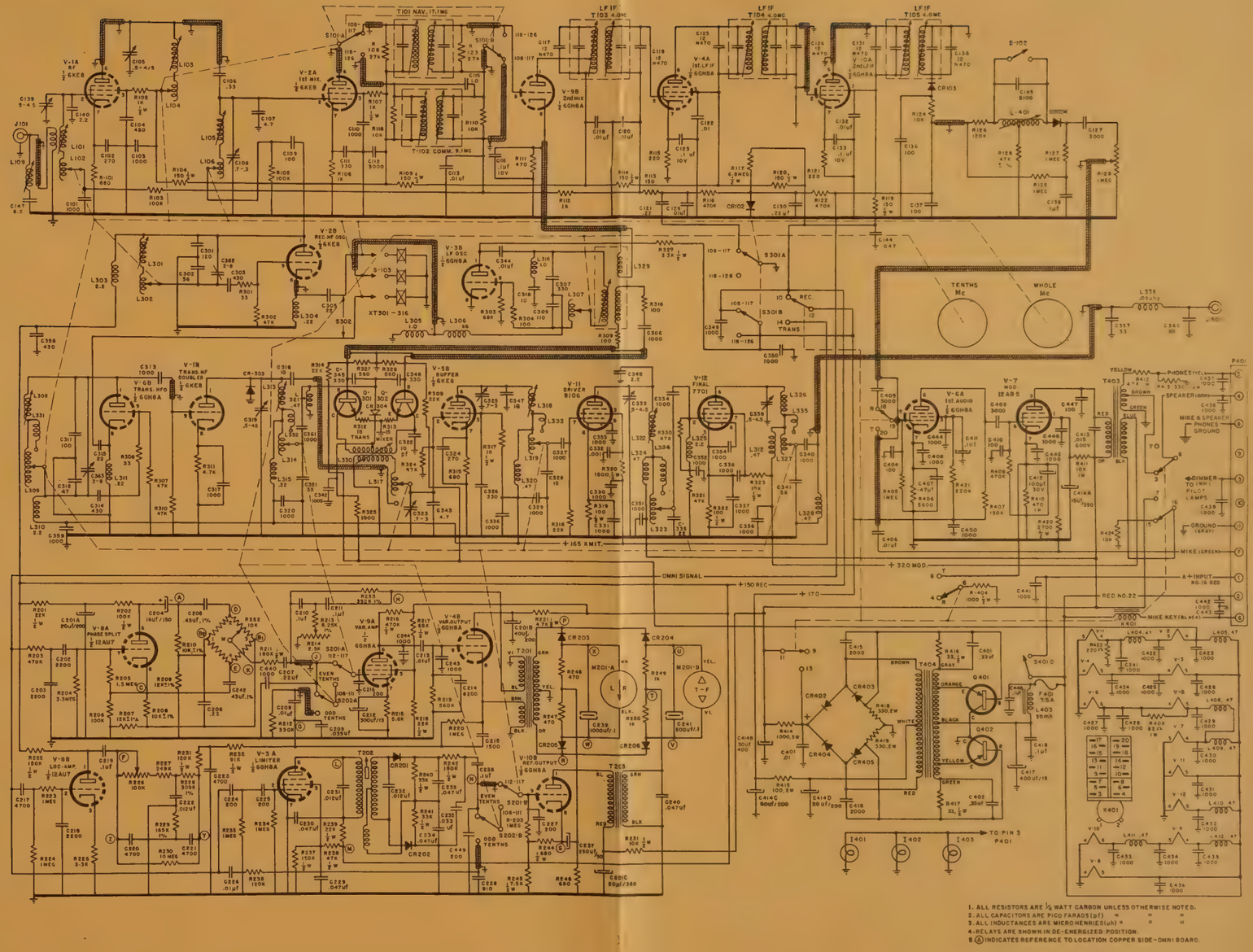
SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
C-206	23085-79	Mylar 100V, 0.22μF, ±10%	CN138-B4
C-207	23085-79	Same as C-206	CN138-B4
C-214	23085-62	Mylar 200V, .0082μF, ±10%	CN138-A11
C-222	23085-464	Mylar 100V, .012μF, ±5%	CN138-B1
C-304		Not Used.	
C-310		Not Used.	
C-319	22019-1	Same as C-105	CN138-B1
C-342	21291-21	Capacitor, Ceramic Disc., .001μF, ±20%, 1000V	CN138-B5
C-355	22019-1	Not Used.	
C-362	22041-3	Capacitor, Trimmer, 2-8pF, 500 V	CN138-B2
C-363	22041-3	Capacitor, Trimmer, 2-8pF, 500 V	CN138-B2
C-401	23072-37	Capacitor, Dipped Mylar, .33μF, 50V, ±20%	CN138-B
C-402	23072-37	Same as C-401	CN138-B
C-411	23085-175	Mylar 200V, 0.1μF, ±10%	CN138-A9
C-415	21291-15	Ceramic, Disc, 500V, .002μF, ±10%	CN138-B
C-416	21291-15	Same as C-415	CN138-B
CR-304	75013-6	Diode, Silicon	CN138-A11
F-401	66501-2	Fuse, Quick Acting, 7.5 Amp, 32V	CN138-B
K-401	65126-24	Relay, 12V, D.C., 6PDT	CN138-A9
L-306	11138-6	R.F. Choke, 0.68μH	CN138-A8
L-323	61490-101	2nd Buffer, Var. Inductor	CN138-A10
L-327	61490-101	Same as L-323	CN138-A10
R-213	31199-289	Metal Film, 8.25K ohms, ± 1%, ¼W	CN138-A10
R-215	31192-562	Carbon 5.6K ohms, ±10%, ¼W	CN138-B1
R-219	31195-564	Carbon 560K ohms, ±5%, ¼W	CN138-A11
R-306		Not Used.	
R-324	31192-473	Resistor, Carbon, 47K ohms, ±10%, ¼W	CN138-B3
R-329	31192-473	Carbon 47K ohms, ±10%, ¼W	CN138-B3
R-416	31141-330	Wire 33 ohms, ±10%, ½W	CN138-B
R-417	31141-330	Same as R-416	CN138-B
XT-316A	72020-17	Crystal 61.2000 Mc/s	For 122.4 Mc/s.
XT-316B	72020-18	Crystal 61.2500 Mc/s	For 122.5 Mc/s.
XT-316C	72020-19	Crystal 61.3000 Mc/s	For 122.6 Mc/s.
XT-316D	72020-20	Crystal 61.3500 Mc/s	For 122.7 Mc/s.

Reference page 41, in original Manual



1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf)
3. ALL INDUCTANCES ARE MICRO HENRIES (μh)
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE - OMNI BOARD.

Figure 7a.
SCHEMATIC, *narco* Mark-III,
for CN138-B5.



1. ALL RESISTORS ARE 1/2 WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (uh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE - OMNI BOARD.

Figure 7a.
SCHEMATIC, *narco* Mark-III,
for CN138-B5.

Ref. R-0223 ECN-5051 6-9-66

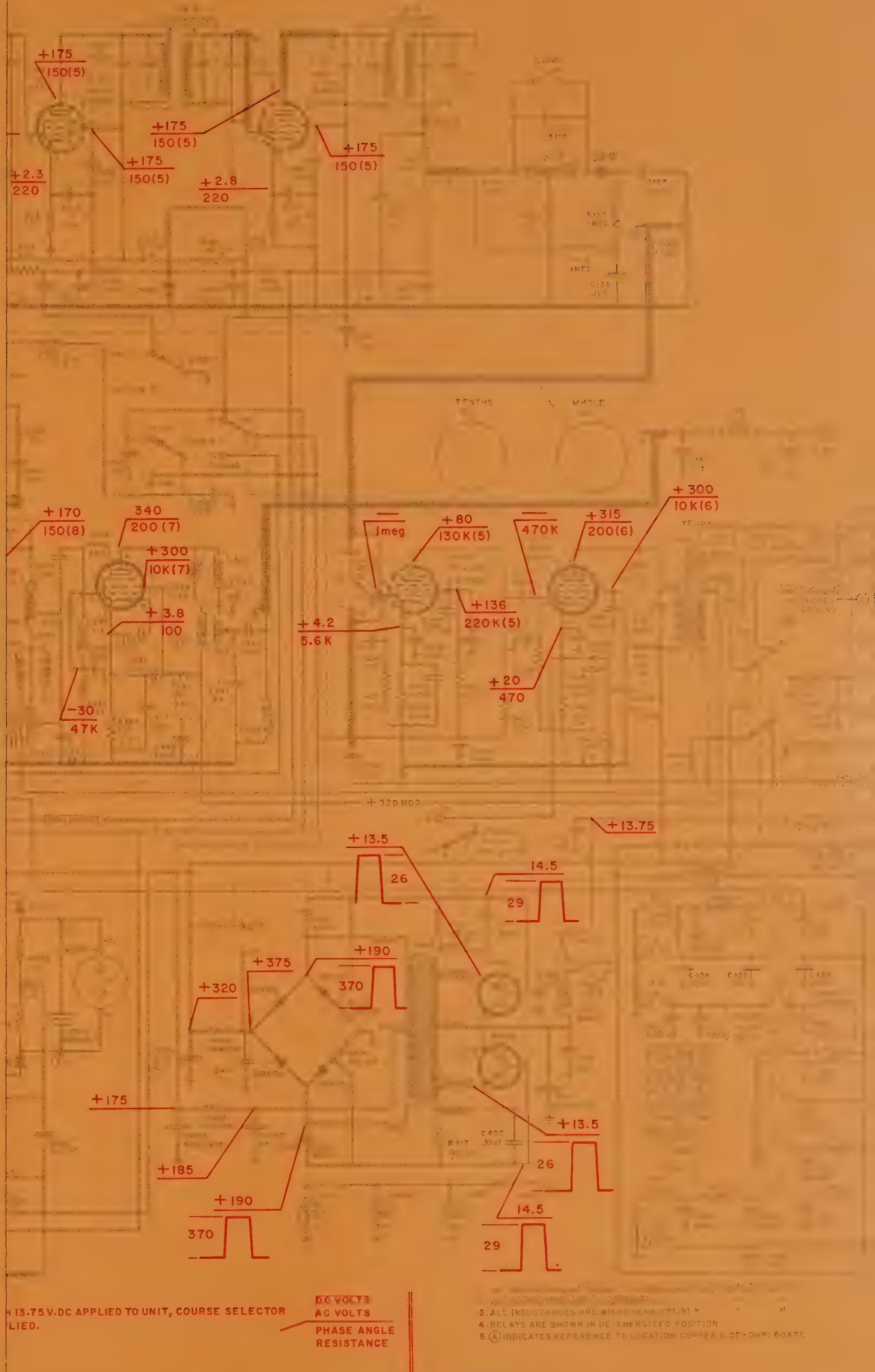
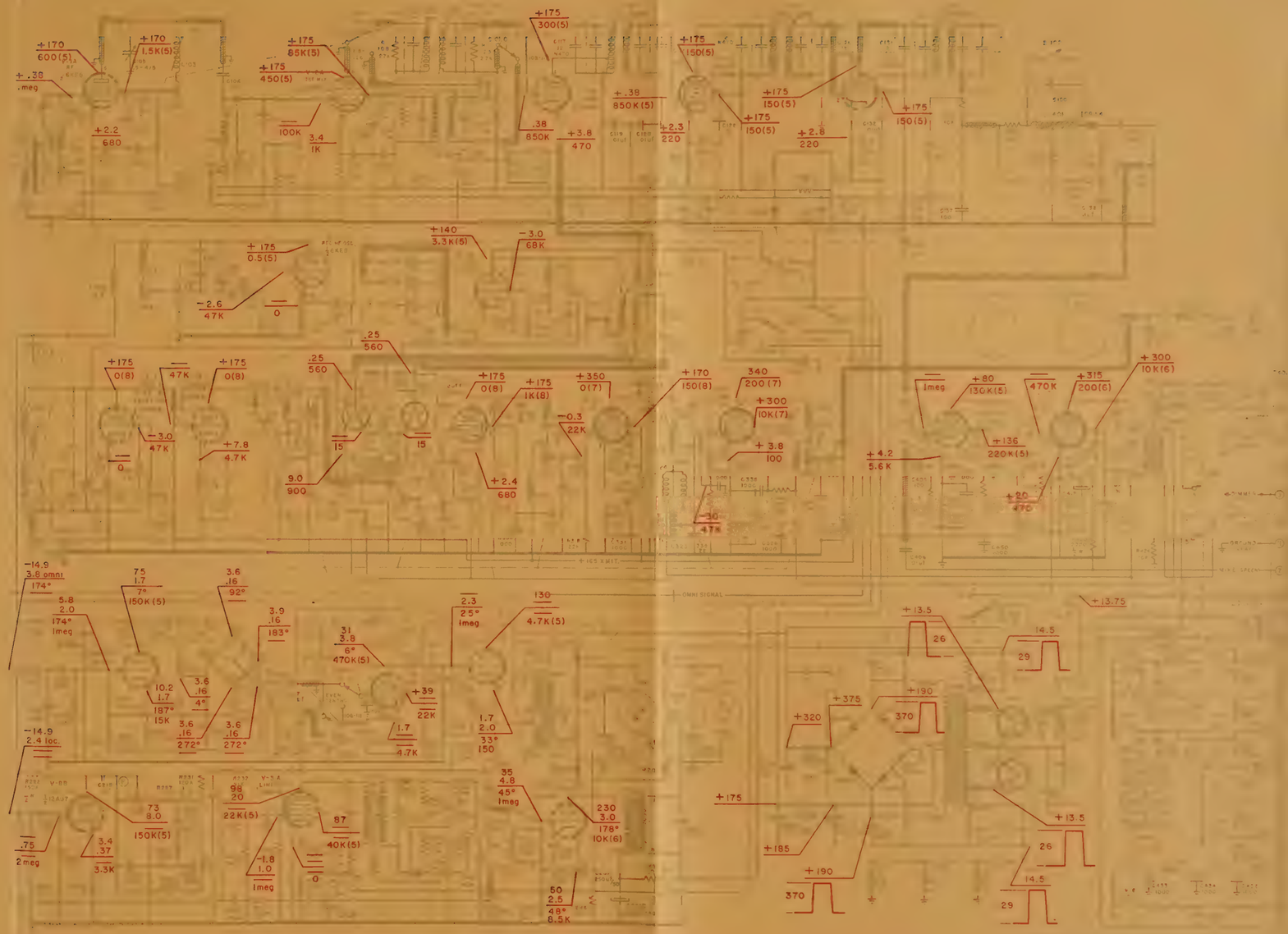


Figure 8a.
SCHEMATIC with TEST DATA Overprint.
narco Mark III,
for CN138-B5
- 73 - Extension


NOTES:
1. ALL VOLTAGES, RESISTANCES AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE NOTED.
2. ALL RECEIVER VOLTAGE MEASURED WITH VOLUME CONTROL FULL CCW, NO SIGNAL INPUT AND 13.75 V. DC APPLIED TO UNIT.
3. ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V.DC APPLIED TO UNIT.
DC VOLTS
RESISTANCE
4. ALL OMNI VOLTAGES MEASURED WITH 13.75 V.DC APPLIED TO UNIT, COURSE SELECTOR SET AT 0°, 500 µV. OMNI SIGNAL APPLIED.
5. MEASURED TO C414, SECTION "C".
6. MEASURED TO C401.
DC VOLTS
AC VOLTS
PHASE ANGLE
RESISTANCE
OMNI SIGNAL

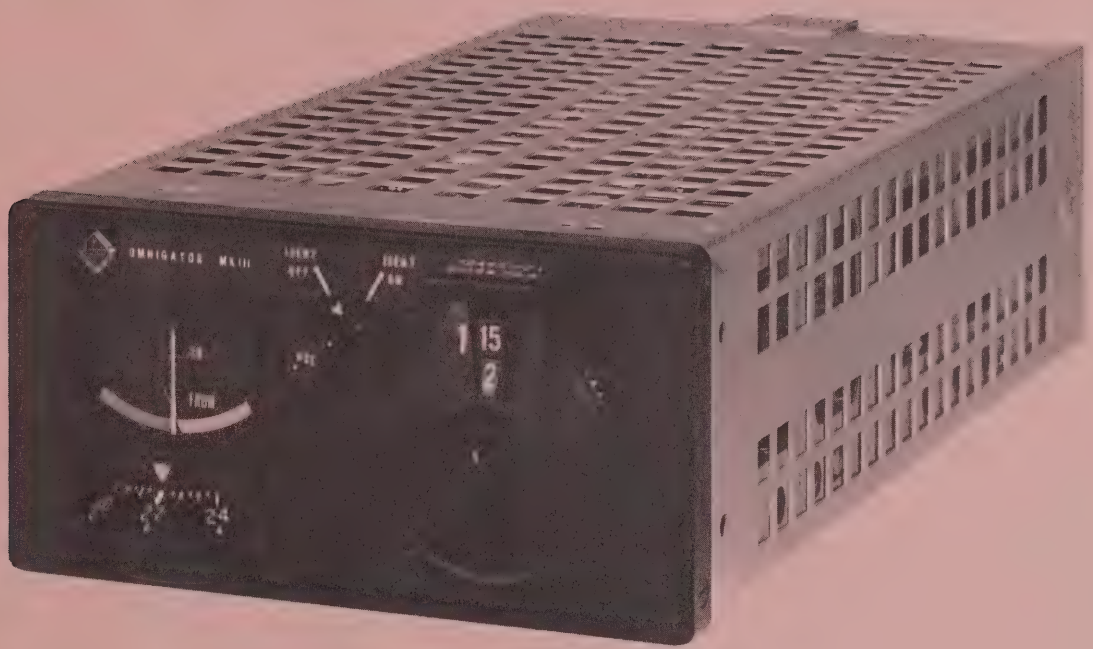
Ref. R-02223 ECN-5051 6-9-66

Figure 8a.
SCHEMATIC with TEST DATA Overprint.
narco Mark III,
for CN138-B5
- 73 - Extension

SUPPLEMENT 2

Place this sheet at the front of the original manual (MM-220) and Supplement 1 to indicate that Supplement 2 is included in this maintenance manual.

NARCO OMNIGATOR MARK III



MAINTENANCE MANUAL SUPPLEMENT No. 2

for CN138-B6 and CN 138-B7

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
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Supplement 2

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NARCO OMNIGATOR MARK III

MAINTENANCE MANUAL SUPPLEMENT No. 2

for CN138-B6 and CN138-B7

Remove the front cover sheet and place at the front of this Mark II Maintenance Manual to indicate that the manual has been updated to include all chassis changes up to CN138-B7. Supplement 2 can be inserted into the original manual on a page-by-page substitution or the complete supplement can be placed at the rear of the Mark III binder. Each new or revised paragraph in this supplement is identified with a vertical black bar at the outside margin of the paragraph or illustration.

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NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

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INTRODUCTION.

This is Supplement No. 2 to the original Mark-III Maintenance Manual MM-220 (3076-600) dated September 1965. The supplement is intended to document the changes in Chassis No's. CN138-B6 and CN 138-B7 of the Mark-III Omnigator. The differences associated with all other chassis numbers (CN138-A to CN138-5) are described in Supplement 1, dated May, 1966.

The parts list in the supplement affects only the chassis indicated in the extreme right column. The items identified with chassis number CN138-B7. Please note that capacitors C-118, C-125, C-126, C-131, and C-135 apply to only the CN 138-B7 chassis since these components are associated with the actual I.F. transformers (T-103, T-104, and T-105) used on this chassis. If a new IF transformer is ordered, use the part number appearing in the original manual for both the transformer and the associated shunting capacitor. When ordering any of the above capacitors for any chassis other than CN138-B7, refer to the parts list in the original manual.

ADDITIONS AND CORRECTIONS

Unless otherwise indicated, the "CORRECTIONS" and "ADDITIONS" listed on Pages 57 and 58 of Supplement 1 are valid. The information given below must be added to the above changes to make a complete Mark-III documentation of chassis differences. This supplement includes the CN138-B7 schematic: for the CN138-B6 schematic, refer to the description of "PRODUCTION CHANGES" listed on the left apron of the B7 schematic (Figure 7b, Page 47).

Various components have been changed to: (1) improve transmitter performance under high ambient temperatures and low line voltage operating conditions; and (2) more efficiently suppress power supply switching transients. Other components have been changed to improve the temperature stability of the OMNI, LOCALIZER, and receiver circuits.

The photographs of Figures D,a and G,a have been revised to show the new components.

The R.F. Amplifier and Mixer Circuit alignment procedure has been added as paragraph 5-F,7: paragraph numbers 5-F,8 and 5-F,9 have been changed to suit.

The parts list on Page 93 has a complete list of the parts affected with the part numbers and descriptions necessary for ordering replacement parts. Where changes have been made to any pages, the affected paragraphs or illustrations have been identified by placing a black vertical bar at the margin edge. The reverse side of each page has been reprinted so as to permit inserting the revised pages into the original manual on a page-by-page substitution basis.

To locate the above pages, please refer to the Table of Contents on Page 75.

NOTE

In this maintenance manual any page number below 53 is located in the original manual; any page number between 55 and 73 is in Supplement 1; and any page number above 75 is in Supplement 2.

SECTION 2
INSTALLATION

2-A. INTRODUCTION.

The ***narco*** Mark III Equipment consists essentially of a single unit with front panel controls for direct manual operation by the pilot. It is normally installed in or near the instrument panel, for operating convenience. Installation usually involves primarily the permanent mounting of the case. Installation and removal of the unit proper is then accomplished by operating the latch at the front and connecting or disconnecting the cables at the rear.

To complete the installation the following items are required, if they are not already available. Two antennas (receive and transmit), headphones or loudspeaker or both, and a microphone. For details see the succeeding paragraphs in this section and the diagrams in Section 6.

2-B. UNITS & ACCESSORIES SUPPLIED.

1. ***narco*** Mark III PANEL UNIT with case.
2. CABLE Assembly, 54" long, for Power, Audio and Dimmer circuits, ***narco*** No. 90632-54.
3. Plug for Receiver Antenna, ***narco*** No. 41237-1.
4. FERRULE, for Plug (Item 3, above), ***narco*** No. 41237-2.
5. PLUG, for transmitter antenna, ***narco*** No. 41130-2

2-C. ACCESSORIES REQUIRED, but not SUPPLIED.

1. ANTENNA and Coaxial R.F. Cable for Receiver. A horizontally polarized dipole is required for Navigation Signals. See Items under 2-G., below.
2. ANTENNA and Coaxial R. F. Cable for Transmitter. A vertically polarized unipole over a suitable ground plane is recommended. See items under 2-G., below.
3. HEADPHONES or LOUDSPEAKER, or both if desired. Headphones, Z=300 to 1000 ohms. Loudspeaker, Z=3 to 6 ohms.
4. MICROPHONE. Low impedance type. A noise cancelling type is recommended.
5. FUSE or other D. C. Power Circuit protection rated at 15 amps.

2-D. OPTIONAL ACCESSORIES.

1. ANTENNA for Receiver.
   narco VRP-15A Pedestal Mounting Type, with 100 inch R. F. Cable ***narco*** Item No. EL-2056.
2. ANTENNA for Receiver.
   narco VRP-37 Tail Mounting Type, with 30 foot R. F. Cable and "Balun." ***narco*** Item No. EL-2060.
3. ANTENNA for Transmitter.
   narco VTP-17 Bent Rod Type, with 100 inch R. F. Cable ***narco*** Item No. EL-2057.
4. ANTENNA for Transmitter.
   narco VP-10 Broad Band Type, with Gasket, Hardware and BNC R. F. Cable Connector, but without R. F. Cable. ***narco*** Item No. EL-2028.
5. KIT, COOLING, ***narco*** Item No. EL-3076-500.
6. KIT, COOLING, Right Angle Type, ***narco*** Item No. EL-3076-501.
7. KIT, MODIFICATION, D.C. Converter. ***narco*** Item No. 3076-602 (may be required in chassis No. CN-138A12 and below when operating at extreme temperature).
8. KIT, FREQUENCY Change, Navigation Transmitter. ***narco*** Item No. EL-3076-503 (122.4, 122.5, 122.6, 122.7 Mc/s).

2-E. MECHANICAL INSTALLATION.

The ***narco*** Mark III equipment is essentially a single unit apparatus in a rectangular metal case. It is intended for Instrument Panel mounting, in a position convenient for direct manual operation by the pilot. The case is open at the front and rear, except for a vertical ground support strap at the rear. Bosses to accommodate mounting brackets are provided at the top, bottom and sides near the front and at the sides near the rear. See Figure 2, Page 28.

The case is normally installed permanently in the aircraft. It is to be fastened by brackets at the front and the ground support stud at the rear. If it is to be mounted in the instrument panel, it may be installed from the front or the rear. It is recommended that it be installed from the rear if possible. This is because, when it is installed from the front it is necessary to make a slightly larger cutout to accommodate the mounting bosses. When this is done the Front Trim Panel will not properly cover the cutout.

Mounting brackets are not supplied because the requirements vary considerably among the various installations. Brackets can be readily fabricated from metal sheet, or angle stock.

With the case properly installed the unit can be easily put in place. It is done by passing the short cable with a connector thru the case and then, when the unit is properly positioned, fastening it with the screwdriver operated latch. The latch is accessible thru a hole near the bottom center of the front trim panel. The access hole is covered with a snap-in button.

When the ***narco*** Mark III Equipment is to be mounted in a "stack" with other radio equipment, added cooling is of utmost importance for extended reliability. Cooling is desirable for single radio installations as well. An air inlet is located at the rear, near the lower center of the unit. A ***narco*** accessory kit (EL-2096) may be used to provide the necessary cooling.

Reference page 9 in original manual

2-F. ELECTRICAL CONNECTIONS.

All electrical connections are made to the rear of the Panel Unit Chassis. There are separate connectors for the receiver and transmitter antennas. The case is provided with a ground and support stud near the top of the vertical strap at the rear of the case. The strap also has a grounding jack near the center, which mates with a plug on the chassis. A good electrical connection must be made between the ground and support stud and the metal frame of the aircraft. The remaining connections are made via an eleven circuit connector, P-401, at the end of a short cable extending from the rear of the chassis. This connector mates with J-401 on the Cable Assembly, No. 90632-54, supplied with the equipment. See Figure 1, and Table A, page 27.

2-F,1. Primary Power

A wire, RED No. 16, about 10″ long extends directly from the connector J-401. It should be connected to the aircraft 14 volt D.C. supply via suitable protection. See Item 2-C,5., above.

2-F,2. Dimmer Circuit.

A wire, WHITE No. 22, about 10″ long extends directly from the connector J-401. It connects with the front panel lamps in the unit and may be connected to a common instrument-panel lamp-dimmer circuit. If no external connection is made the wire may be connected to terminal No. 2 in J-401. This provides +14 volts D.C. to the panel lamps, via the ON-OFF switch associated with the volume control on the Front Panel.

2-F,3. Power and Audio Cable Circuits.

A five wire cable, 54″ long extends from J-401, along with the RED and WHITE wires noted under 2-F,1., and 2-F., above.

The BLUE, WHITE, BROWN and BLACK wires are properly connected to the mike and phone jacks supplied by the installer. The two jacks, for headphones and microphone, are normally mounted on the instrument panel at a place convenient for the pilot. See Table A, page 27.

The GREEN wire for the loud-speaker is unterminated. It may be extended if necessary, to reach the speaker.

2-G. ANTENNAS.

2-G,1. Receiving Antenna.

The full range and accuracy of the VHF omni-range system can be realized only when the airplane is equipped with the proper type of antenna. **For omni-range reception, a horizontal "V" dipole antenna is absolutely necessary. A vertical whip is definitely not satisfactory,** although it may appear to be when tried. Vertically polarized components are not radiated by the ground stations, but are produced by reflections from trees and similar objects. Therefore a vertical antenna may receive strong signals, but they are reflections and do not come directly from the ground station, giving rise to very unreliable bearings.

The ***narco*** Type VRP-15A horizontal "V" dipole antenna when used should be carefully installed preferably on top of the airplane behind the cockpit, and well away from the engine and propeller. An alternate type of antenna, ***narco*** Type VRP-37, is available for mounting on the upper part of the vertical stabilizer. The nose of the "V" dipole should face directly forward or aft, and the rods should be horizontal in level flight altitude.

The mast of the type VRP-15A antenna contains a matching "BALUN" which serves as an impedance transformer and as a means to connect a coaxial line to the balanced "V" dipole antenna. The type VRP-37 antenna is available with an external "BALUN" which attaches to the antenna rods. The other end of the "BALUN" is factory connected to the coaxial R.F. Cable which connects to the equipment. Either "BALUN" is made of coaxial R.F. Cable cut to critical dimensions which should not be altered. The sheath of the coaxial line to the receiver should be connected to the sheath of the "BALUN" cable and grounded directly to the metal surface of the aircraft. The VRP-15A mast includes this connection in its base. The VRP –37 Cable assembly is provided with a grounding lug for making this connection.

2-G,2. Transmitting Antenna.

The vertical rod type transmitting antenna, such as the ***narco*** VTP-17, should be mounted on a metal surface measuring at least 18 inches square to serve as a ground plane. Such a mounting surface is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface is available a piece of thin aluminum may sometimes be affixed flush with the fabric. This thin aluminum sheet or foil may be made to conform to the various curved surfaces to which it is mounted, but all cuts and seams should be along lines radiating from the antenna base. A ½ inch hole should be made in the center of this sheet for mounting the antenna. It is recommended that where necessary a metal reinforcing plate be provided to resist the bending load imposed by the slip-stream. The ***narco*** VTP-17 antenna should not be lengthened or shortened. It has been cut to the proper length for the most efficient radiation at the frequencies generated by the transmitter.

2-G,3. Antenna Cables.

The type VTP-17 transmitting antenna and the type VRP-15A receiving antenna are both available with 100 inch lengths of 52 ohm coaxial transmission line, type RG-58A/U. The alternate type of receiving antenna, type VRP-37, is available with 30 feet of RG-58A/U, 52 ohm coaxial transmission line with an attached "BALUN."

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in original manual**

are retained by a notched black phenolic rod which must be removed to remove a switch section. To remove this retainer rod proceed as follows:

a. Remove the "D Washer" on the front of the metal front sub-panel, near the panel lamp I-402. See Photo B, Page 34.

b. Remove the two retainer springs at the top of the first and seventh vertical metal shields.

Note that the ⅜" O.D. shaft should be removed before removing the retainer rod and be replaced after the retainer rod is back in position, to avoid difficulty. The removal and replacement of a particular section will depend on its connections. The procedure must be determined by inspection.

5-C,6. Quartz Crystals.

All 16 Quartz frequency control crystals XT-301 thru XT-316 are assembled on a printed circuit board between the two switch sections S-302 and L-307/S-103.

The crystals are of the wire-in type. Removal and replacement must be done carefully. The procedure is to disconnect the lead to S-302, first and then, using printed circuit techniques, disconnect both leads from the printed circuit board. For details concerning printed circuit board. For details concerning printed circuit methods refer to 5-I., page 24.

5-D. ELECTRICAL MAINTENANCE.

5-D,1. Equipment Required.

1. R.F. Power Wattmeter, Bird Termaline Model 61, or equivalent.
2. DC Vacuum Tube Voltmeter (DC VTVM), RCA Senior Voltohmyst, with WG-301A Crystal Diode Probe, or equivalent.
3. AC Vacuum Tube Voltmeter (AC VTVM), Ballantine Model 300, or equivalent.
4. Low Impedance Microphone, with "push-to-talk" button.
5. MF/HF Signal Generator, General Radio Model 1001-A, or equivalent.
6. VHF Signal Generator, Hewlett-Packard Model 608-D, or equivalent.
7. Audio Wattmeter, General Radio Type 583-A, or equivalent.
8. Low Voltage D.C. Supply, 12-15V., dc at 10 to 15 amperes, Electro Products Laboratories, Model NFB, or equivalent.
9. Omni Signal Generator, Aircraft Radio Corporation, Model H-14A, or equivalent.
10. For phase angle measurement, four additional pieces of equipment are required, as indicated in the Test Setup Diagram, Figure 6, page 33.

5-E. OVERALL OPERATING CHECK.

5-E,1. Receiver.

Procedure:

a. Refer to the "Receiver Test Setup", Figure 4, page 32.

b. Connect the audio output (5 watts full scale), meter to the output cable Pins 4 and 8 on J-401/P-401.

c. Connect the AC VTVM to TL-20, terminal No. 5 (2 VAC full scale). Refer to Schematic Diagram, Figure 7, page 51 (Junction R-124 and C-137).

d. Connect the VHF Signal Generator to the antenna connector J-101. Set the Signal Generator for a 108.0 Mc. thru 126.9 Mc/s range, with 1000 cps, 30% modulation.

Normal Indications:

e. A signal of 3.5 μv maximum should produce a detector output of 1.3V RMS and 1.5 watts minimum (volume control at maximum) on all NAV channels.

f. A signal of 6 μv maximum should produce a detector output of 1.3V RMS and 1.5 watts minimum (volume control at maximum) on all COM channels, or 10 milliwatts (1 set phones, 600 ohms).

g. A signal of 1.5 μv maximum should produce 6db signal plus noise to noise at the speaker output in all NAV channels.

h. A signal of 2.5 μv maximum should produce 6 db signal-plus-noise to noise at the speaker output on all COM channels.

i. If normal indications are not obtained, refer to the procedures outlined in the paragraphs under 5-F., below.

5-E,2. Transmitter.

Procedure:

1. Refer to the "Transmitter Test Setup", Figure 5, page 32.
2. Connect the R.F. Wattmeter to J-301, the transmitter antenna connector, in place of the antenna.
3. Place the Channel Selector on any COM channel, 118.0 thru 126.9 Mc/s.
4. With the "Push-to-talk" Microphone connected, activate the transmitter.
5. Check all transmitter channels over the complete range of 118.0 thru 126.9 Mc/s.

Normal Indication:

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Power output should be a minimum of 2 watts on all channels without modulation. Voice modulation should cause a slight increase in the output power.

If a normal indication is not obtained, refer to the procedures outlined in the paragraphs under 5-G., below.

5-E,3. OMNI and Localizer Circuits.

a. Connect the test equipment to the receiver as shown in Figure 6, page 33.
b. Set the receiver Channel Selector dial to an OMNI channel.
c. Set the R.F. Signal Generator output at 500 microvolts. Set the OMNI course selector at 0° with the modulation switch on the OMNI position.
d. Set the receiver course selector dial to 0°. The Left-Right needle should read center, and a full "TO" flag should show. Rotate the Omni signal generator to 180° and note any Left-Right needle swing. Full "FROM" flag should show.
e. Check course selector heading against OMNI Signal Generator headings. They should agree within ±4°.
f. Set Omni signal generator for localizer signal output. Set the receiver dial for an odd tenth megacycle channel 108.1 thru 111.9 Mc/s.
g. Check centering of left-right needle. A change of 4 db localizer signal will give deflection to the edge of the color sections.

5-F. RECEIVER ADJUSTMENT PROCEDURES.

5-F,1. High Frequency Oscillator (HFO).

Connect the DC VTVM as shown in the Receiver Test Setup, Figure 4, page 32. The drive at Pin 9 of V-2B should be –3.0 VDC minimum. If it is less, Select 126 Mc/s and peak L-301 for maximum negative voltage, then Select 118 Mc. and peak C-304 for maximum negative voltage. Repeat the procedure until the drive is approximately flat across all Mc/ channels.

5-F.2. Low Frequency Oscillator (LFO).

Connect the DC VTVM as shown in the Receiver Test Setup, Figure 4, page 32. The drive at Pin 9 of V-3B should be –3.0 V. dc minimum on any Tenths Mc/s channel. If it is less, Select the 0.0 channel and peak L-329 for maximum negative voltage. The remaining tenths Mc/s positions 0.1 thru 0.9 should then all be in tune.

5-F.3. Intermediate Frequency (IF) Alignments.

In the following several alignment procedures, the results of the signal inputs and tuning procedures will be observed on the AC VTVM connected at the junction of R-124 and C-137. This is the output of the detector CR-103, at TL-20, terminal No. 5. See Photo D, page 36 and the Schematic Figure 7, page 51.

Reference page 22 in original manual

5-F,4. Low Frequency I.F.

Disconnect all components from Pin 9, V-9B, the grid of the second mixer. Connect the MF-HF Signal Generator to Pin 9, V-9B. Terminate the Generator with a 47 ohm resistor and feed the grid through a .047 μf capacitor. A 4.0 Mc/s signal at 300 μv, 400 cps, 30% modulation should produce 1.3 volts ac at the detector. If it does not, check the tuning of the LF IF transformers T-103 through T-105. Tune the primary and secondary slugs of all transformers for maximum output at the detector, CR-103. Make sure all cores are on the outer peak.

Reconnect all components to Pin 9, V-9B.

5-F,5. NAV High Frequency I.F.

a. Set the Channel Selector to 108.5 Mc/s.
b. Disconnect all components from Pin 2, V-2A and connect the Signal Generator to Pin 2. Terminate the Generator with a 47 ohm resistor and feed the grid through a .047 μf capacitor. (Refer to Crystal Frequency Table I, page 29.) Note the HF IF Frequency for the 0.5 Mc/s channel.
c. Set the MF/HF Signal Generator to the Selected frequency. A level of 20 μv (400 cps, 30% modulation) should produce approximately 0.5V. ac at the detector output, CR-103.
d. Now set the tenths Mc/s dial to the 0.0 channel. Set the Generator to the proper frequency and repeak the primary and secondary by adjusting the cores for maximum output at the detector, CR-103.
e. Reset the tenths Mc/s dial to the 0.9 channel. Reset Generators to the proper frequency and again repeak for maximum output at the detector, CR-103.
f. Check the output at the 0.0, 0.5, and 0.9 Mc/s points. Output at the 0.0 and 0.9 Mc/s points should be approximately the same. Output at the 0.5 Mc/s channel should be about 1 db below the end point values.

5-F,6. COM High Frequency I.F.

a. Set the Channel Selector to 118.5 Mc/s and repeat Steps c., thru f., under 5-F,5., above, using the proper HF IF and adjust T-102 to obtain approximately flat output across all tenths Mc/s channels.
b. Reconnect all components to Pin 2, V-2A.

5-F,7. R.F. Amplifier and Mixer Circuits.

Refer to Figure 4 for the receiver test setup and connect the test equipment as described in 5-E, steps b, c, and d. Refer to Figure 11 for location of alignment controls and proceed as follows:

a. Set the Channel Selectors and Signal Generator frequency selector to 126.5 Mc/s (6.0 μv output level).

b. Peak L-105, L-103, and L-101 for maximum output at the VTVM and/or the audio output meter.
c. Repeat step b. in the same order since there is some interaction between these circuits.
d. Set the Channel Selectors and the Signal Generator frequency selector to 108.5 Mc/s (6.0 μv input).
e. Peak C-108, C-105, and C-109 for maximum output at the VTVM and/or the audio output meter.
f. Repeat step e. in the same order since there may be some interaction between these circuits.
g. Set the Channel Selectors and the Signal Generator frequency selector to 126.5 Mc/s and repeat step b. and c. since there may be come interaction between the low and high ends of the band.
h. Set the Channel Selectors and the Signal Generator frequency selector to 108.5 Mc/s and repeat steps e. and f.

5-F,8. Audio Circuits.

As noted under 5-E,1.,f, above a signal of 6 microvolts to the input of the receiver should produce an audio signal of 1.3 volts at the output of the detector, CR-103, on all COM Channels. With the receiver volume control at maximum the above signal should provide a 0.25 Volt signal at the grid of the first audio amplifier V-6A, terminal 2. This in turn should provide a signal of 15 volts at the grid of the output amplifier V-7, terminal 6.

With the above condition the audio level across the RED and ORANGE leads of T-403 should be about 150 volts. This should provide about 2.5 watts of audio power to a loud speaker having an impedance between 3 and 6 ohms.

5-F,9. Automatic Volume Control (AVC).

The AVC threshold is that point at which the AVC line starts to go negative as a result of a signal increase.

It may be measured at TL-20, Terminal 3. See Photo D, page 36.

The AVC line should start to go negative when the detector, CR-103, output level reaches 1.3V., ac $\pm$0.1 V., ac. The detector output level may be measured at the junction of R-124 and C-139, which is located on TL-20, Terminal 5. See Photo D, page 36.

The AVC threshold is controlled by the value of R-117. One end of the R-117 may be located on TL-20, Terminal 3.

The AVC characteristic is such that a change of signal input level from 10 μv to 10,000 μv should produce a maximum of 4 db increase in the audio output signal.

5-G. TRANSMITTER ADJUSTMENT PROCEDURES.

5-G,1. High Frequency Oscillator (HFO).

With the equipment connected as shown in the Transmitter Test Setup Diagram, Figure 5, page 32 refer to the Schematic Diagram, Figure 7, page 51. The drive at the grid of V-6B, Pin 9, should be –3.0 V.dc minimum on all COM Mc/s channels. If it is less, select 126 Mc/s and peak L-308 for maximum voltage. Then, select 118 Mc/s and peak C-310 for maximum voltage. Repeat this procedure until the drive is approximately flat over all Mc/s channels.

5-G,2. High Frequency (HF) Doubler.

The rf voltage at the grid of the H.F. Doubler should be approximately 3 volts RMS. It may be measured with the DC VTVM and its Diode Probe.

5-G,3. Low Frequency Oscillator (LFO).

The drive at the grid of V-3B should be at least –3.0 V. dc measured through a 1 megohm resistor in series with the VTVM. If it is less, Select the 0.0 Kc/s channel and peak L-329 for maximum negative voltage. The remaining tenths Mc/s position 0.1 thru 0.9 should then all be in tune.

5-G,4. Balanced Mixer.

The Balanced Mixer involving Q-301 and Q-302 receives energy from both the transmitter HF Doubler, -1B, and the common LFO, V-3B. Energy levels from the HF Doubler and LFO are quite low. They can be measured with the DC VTVM and its Diode Probe.

a. To measure the level from the LFO de-activate the HF Doubler by removing the tube V-6. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.15 volt RMS.

   If the voltage is too low the adjustment of L-313 should be peaked at 126.5 Mc/s and C-319 should be peaked at 118.5 Mc/s. See Photo D, page 36. These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

   Replace V-6 as soon as the measurement is completed.

b. To measure the level from the HF Doubler deactivate the LFO by removing the tube V-3. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.25 Volt RMS.

   Replace V-3 as soon as the measurement is completed.

c. The combined voltages from the LFO and the HF Doubler at the bases of Q-301 and Q-302 should be alike and approximately 0.5 Volt RMS.

5-G,5. Buffer.

The buffer stage, V-5B, receives its grid from the output of the Balanced Mixer, Q-301 and Q-302. This drive is at the desired transmitter output frequency, but at a low level. It may be measured with the DC VTVM and its Diode Probe, at terminal 2 of V-5B. The voltage should be about 1.0 Volt RMS.

If the voltage is too low L-330 should be peaked at 126.5 Mc/s nd C-323 a 118.5 Mc/s. See Photo D. These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

Reference page 23 in original manual

NOTE

Allowance should be made for some loading effect of the probe connection. This may be done by re-checking the peaking with the probe connection on the Driver grid (V-11, terminal 7).

5-G,6. Driver.

The voltage at the grid of the driver, V-11, pin 7, should be –0.3 V. dc minimum. If it is less, proceed as follows:

1. Select the 0.5 Mc/s position on the tenths Mc/s Selector.
2. Select the 126 Mc/s position on the Mc/s Selector and peak L-313, L-330, and L-318 for maximum negative volts at Pin 7 of V-11 (through a 1 meg-ohm resistor).
3. Select the 118 Mc/s position on the Mc/s Selector and peak C-319, 323 and C-325 for maximum negative volts at Pin 7, V-11.
4. Repeat the above procedure until the drive is approximately flat across all Mc/s channels.

5-G,7. Final Amplifier.

The drive at junction of L-325, R-321, R-330, and C-352 should be at least –45 VDC. If it is less, select the 126 Mc/s channel and peak L-322 for maximum negative volts at the junction of the above components. Then, select the 118 Mc/s channel and peak C-333 for maximum negative volts. Repeat the procedure until the drive is approximately flat across all Mc/s channels.

5-G,8. Modulator.

The transmitter final output amplifier V-12, a type 7701 tube, is modulated by the common Audio Amplifier tube, V-7, via a winding on the output of the transformer T-403.

The audio voice signal from the microphone goes via C-406 to the grid of the first audio stage, V-6A, terminal 2. The level at this point should be about 0.25 volts audio. The level at the grid of V-12, terminal 6, should be about 15 volts audio.

With the above condition the audio level across the RED and ORANGE primary leads on T-403 should be about 150 volts. This represents approximately 5 watts of audio modulation power.

5-H. OMNI CIRCUITS.

5-H,1. Reference Channel Alignment.

To Check the Omni Reference Channel Alignment proceed as follows:

a. Connect the test equipment to the receiver as described under 5-E., above.
b. Connect an oscilloscope to Pin 9 of V-10B.
c. Locate the discriminator transformer T-202. Adjust the primary and secondary cores for maximum undistorted signal as noted on the scope. If, in the process of peaking the primary and secondary slugs, the TO-FROM flag changes direction, you have tuned on a false peak. Look for another peak which will give maximum amplitude without causing the TO-FROM flag to change direction. This is the proper setting.

Reference page 24 in original manual

5-H,2. Variable Phase Alignment.

a. Set the receiver course selector dial to 270°. Set the OMNI Generator dial to 270° also.
b. Located the OMNI Zero Set Control (R-214) marked "OMNI" Photo E page 32. Turn this control to center the Left-Right Indicator.
c. Change the OMNI Generator setting 180° (to 90°) and note if there is any reciprocal error. If there is an error greater than ±4° the meter rectifier balance should be checked.

5-H,3. Rectifier Balance.

To balance the Left-Right Indicator rectifiers proceed as follows:

a. Locate the R-247 & R-248 (470 ohm) on the OMNI board. Photo G, page 38.
b. Compensate either R-242 or R-248 whichever one will allow the meter to center (compensating resistor values of 22K ohm or less, depending on the amount of reciprocal error.)
c. Recheck "TO" course and "FROM" course and adjust compensating resistor value for minimum amount of error.

5-H,4. Localizer Centering Adjustment.

a. Set the receiver to a proper Localizer channel and properly set up the OMNI Signal Generator for a Localizer Signal. Refer to 5-E,3., above.
b. The only compensation available for centering the Left-Right Indicator is the adjustment marked "LOC", See Photo E, Page 37. Turn this adjustment (R-226) to center the needle.

5-I. PRINTED CIRCUIT METHODS.

Printed circuits are very reliable and serviceable when they are properly designed, installed and maintained. However, they may be easily damaged by improper maintenance procedures. The following methods if carefully observed will insure satisfactory repairs.

5-1,1. Tools required.

a. Soldering Iron, small, 40 watts or less.
b. Small Long Nose Pliers.
c. Small Angle Cutters.
d. Small Stiff Bristle Brush, or "solder sipper."
e. Sharp pointed instrument (scriber).

CAUTION:

NEVER place the soldering iron directly on the printed circuit if it can be avoided. EXCESSIVE HEAT will raise the circuit from the board.

5-1,2. Replacement of Small Components.

a. Cut the leads and remove the component from the board.
b. Using the small soldering iron and long nose pliers, lift the remaining ends of the component from the board.
c. With the tip of the iron open the holes in the board by drawing the solder away from the holes.
d. Bend the leads of the replacement component and fit them through the holes (observing polarity, if any.
e. Cut off any excess length.
f. Observe that contact surfaces are clean, then resolder.

SECTION 6
ILLUSTRATIONS

6-A. INTRODUCTION.

Most of the various Tables, Diagrams and Photos except the Electrical Circuit Schematics referred to in the preceding sections have been collected in this section for convenient reference. This arrangement was chosen in preference to the arrangement where the illustrations are located on or near the pages where the subject is discussed. Such an arrangement tends to be inconvenient and confusing when the illustration is needed to cover more than one subject.

The arrangement of this manual is such that wherever it is practical the illustrations are upright with respect to the text, for convenient use.

Section 7, Replacement Parts, follows this section.

Section 8, Schematic, follows the Replacement Parts section as the last item in the Manual. The Schematic is in the form of a two-page "pullout" sheet which can be used while the pages of the text, illustrations, or parts list are open for use.

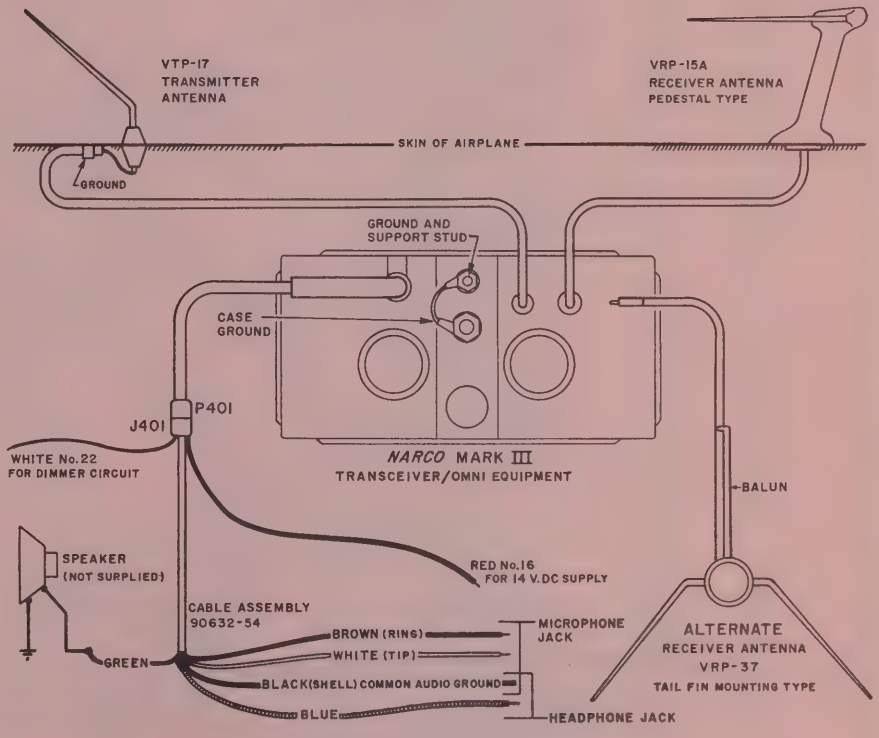
6-B. TABLES and DIAGRAMS.

TABLE A

POWER and AUDIO
CABLE CIRCUITS.

J-401/P-401 Connections

Term. No.	Wire	Circuit
1	RED, #16, 10" Long.	D.C. Supply, +14 Volts.
2	.....	+14 Volts, via ON-OFF Sw.
3	WHITE, #22, 10" Long.	External Dimmer Circuit
4	GREEN, in Cable.	For Loud-speaker.
5	BLUE, in Cable.	For Head-phones.
6	WHITE, in Cable.	T-R Control, (Mic. Jack Tip)
7	BROWN, in Cable.	Microphone (Mic. Jk. Ring)
8	BLACK, in Cable.	Ground for Mic. and Phones.
9	.....	No Conn.
10	.....	No Conn.
11	.....	Ext. Gnd. (optional)



AW-666

Figure 1a
Equipment Interconnections
narco OMNIGATOR Mark-III

**Reference page 27
in original manual**

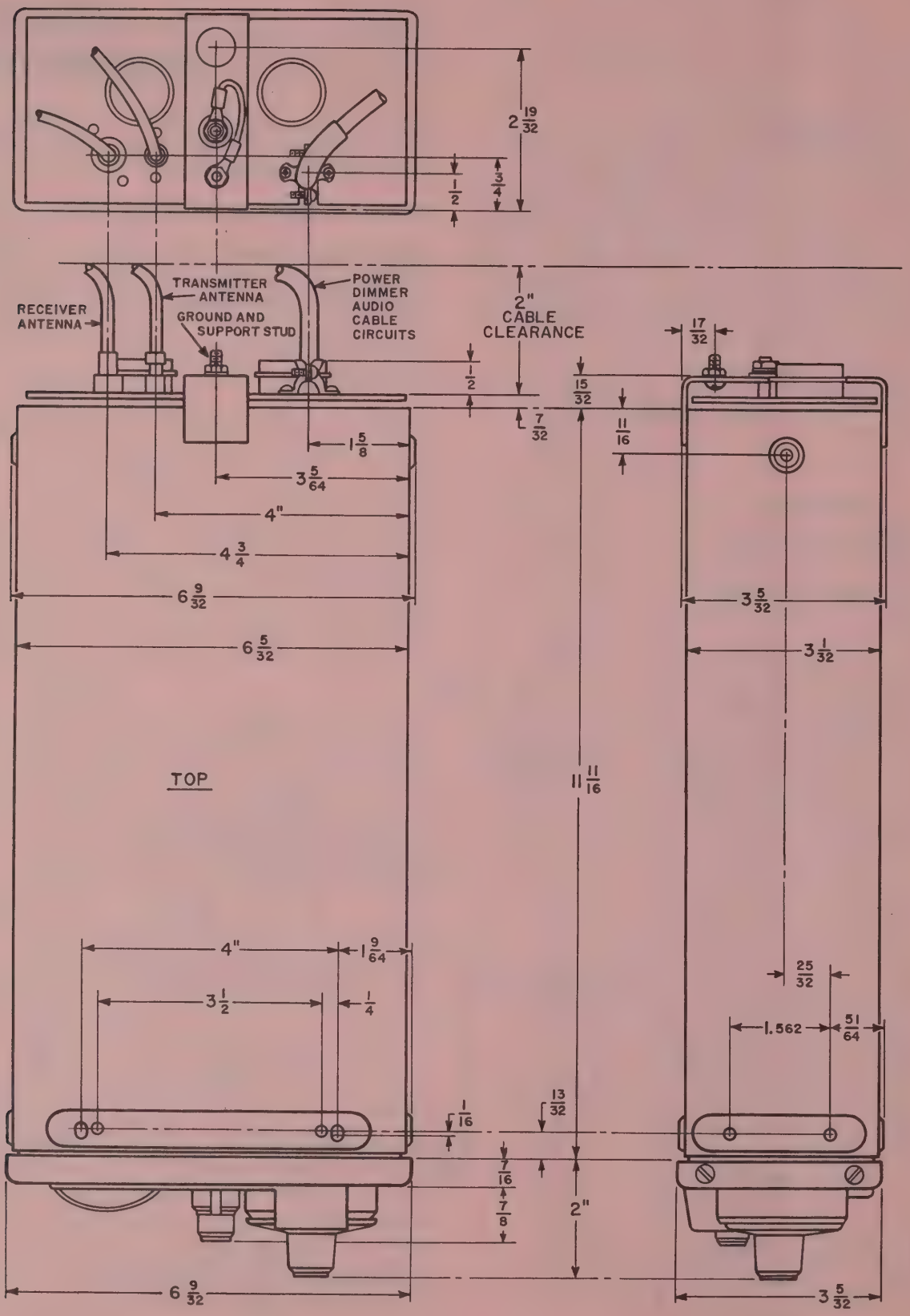


Figure 2.
Mechanical Installation Dimensions
narco OMNIGATOR Mark-III

Reference page 28 in original manual

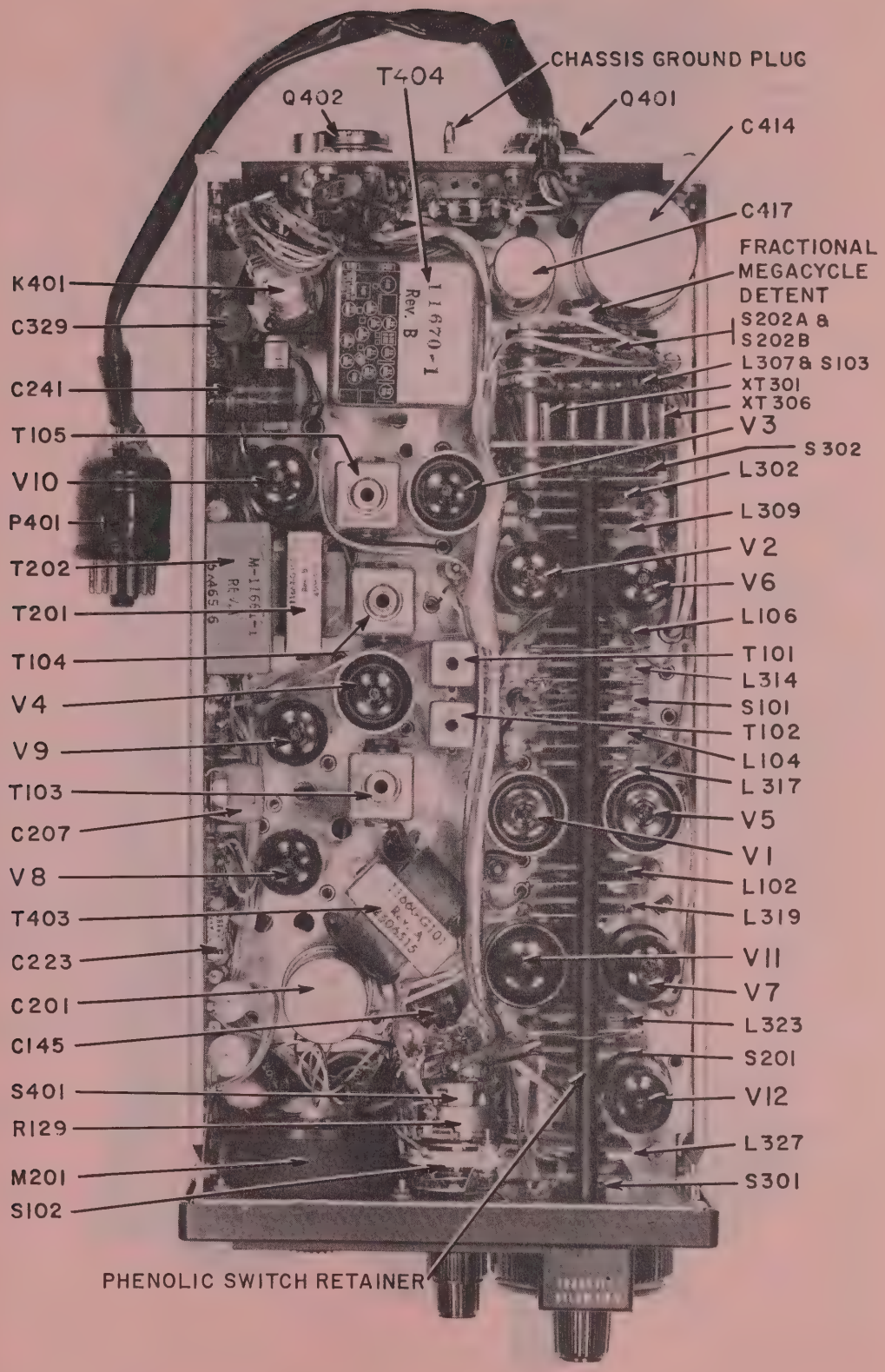
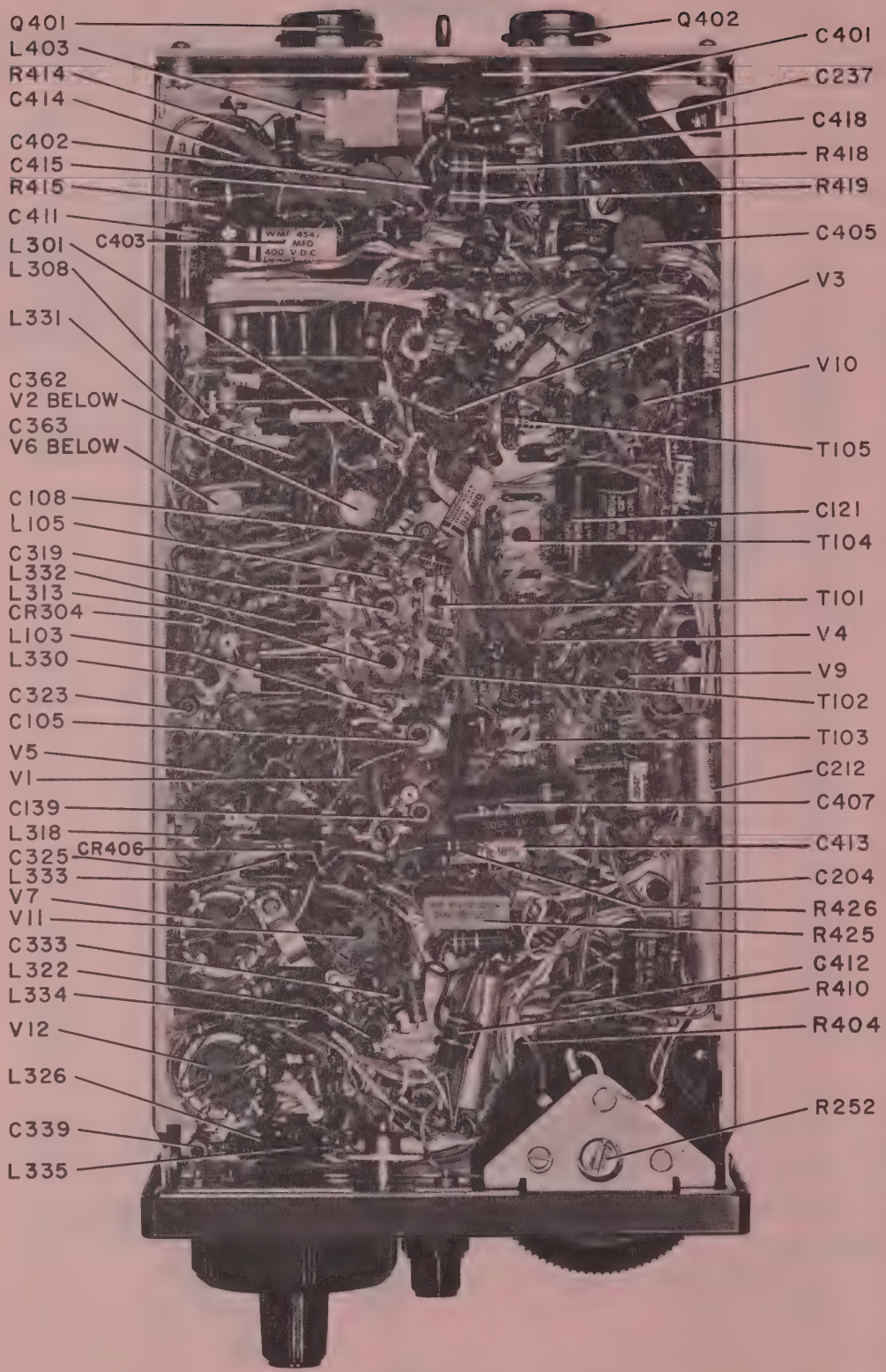


Photo Ca.
TOP VIEW, ***narco*** Mark-III Equipment.

Reference page 35 in original manual and page 65 in Supplement 1

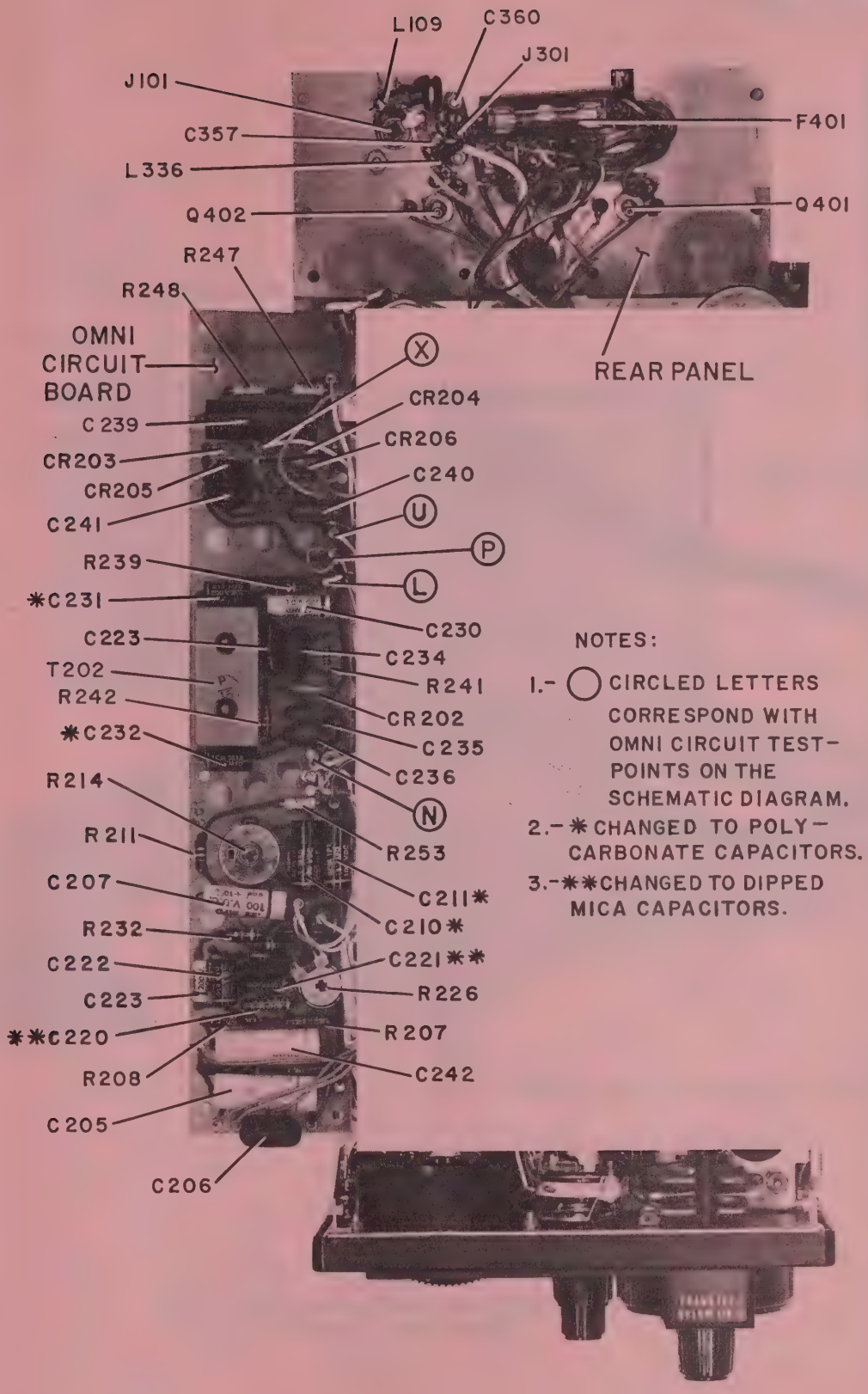


NAR-568

Photo Db

BOTTOM VIEW, ***narco*** Mark-III Equipment.

Reference page 36, in original manual and page 66 in Supplement 1



NOTES:

1.- ◯ CIRCLED LETTERS CORRESPOND WITH OMNI CIRCUIT TEST-POINTS ON THE SCHEMATIC DIAGRAM.

2.- * CHANGED TO POLY-CARBONATE CAPACITORS.

3.- ** CHANGED TO DIPPED MICA CAPACITORS.

NAR-569

Photo G,b

OMNI BOARD (Component Side), and REAR PANEL
narco Mark-III Equipment.

Reference Page 38, in original manual and page 67 in Supplement 1

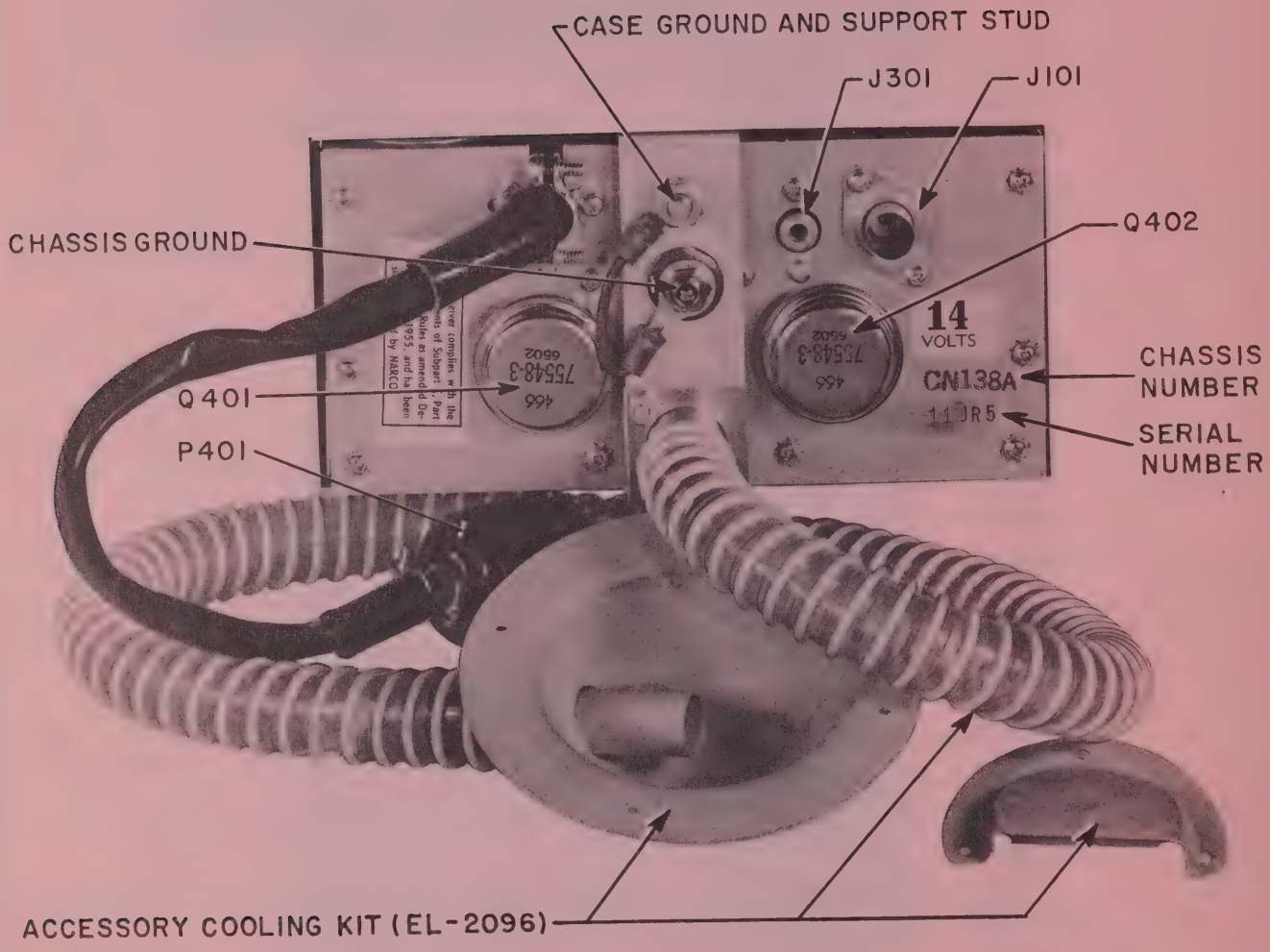
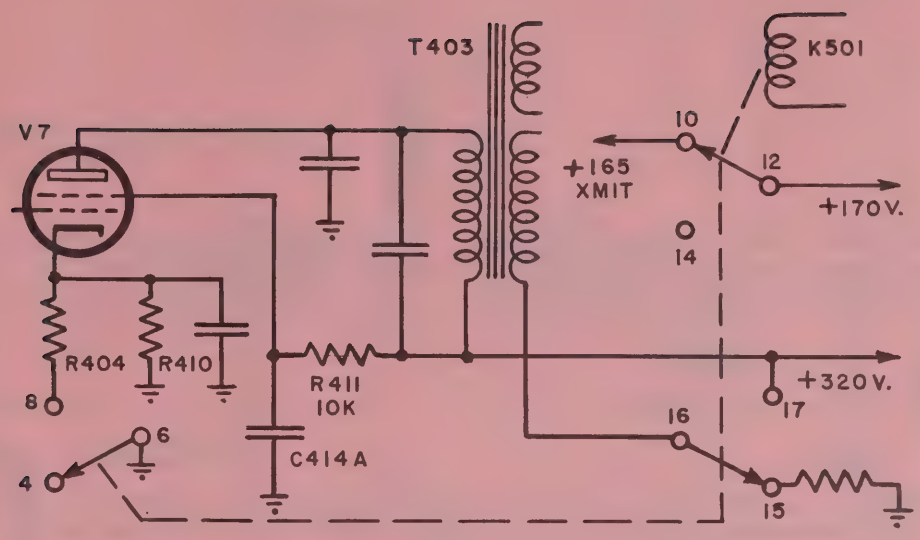


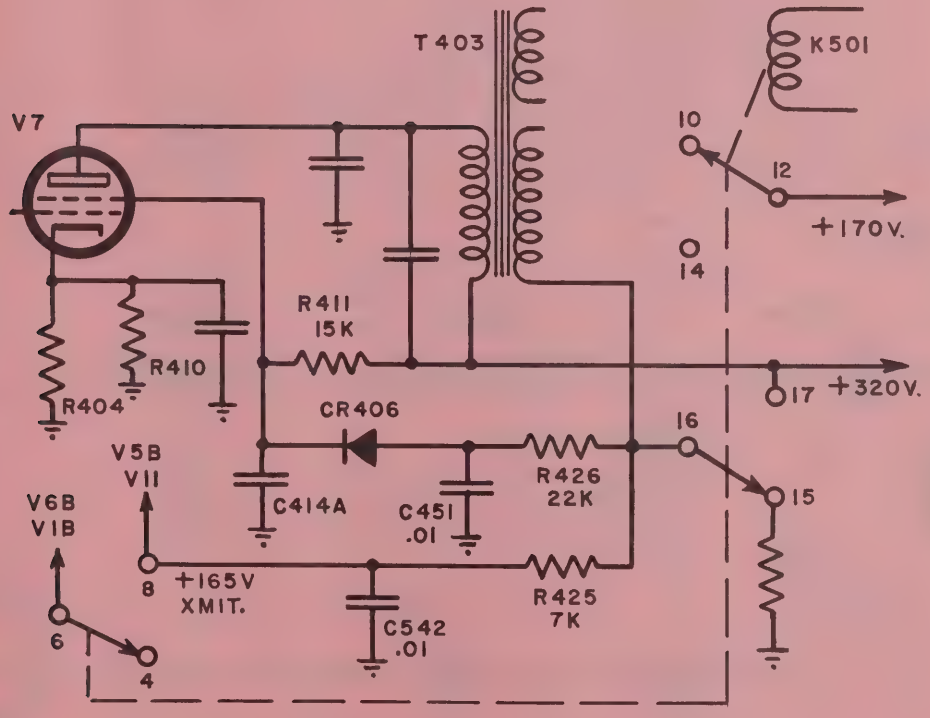
Photo Ha.
REAR VIEW, with CASE and COOLING KIT.
narco Mark-III Equipment

Reference page 39, in original manual and page 68 in Supplement 1

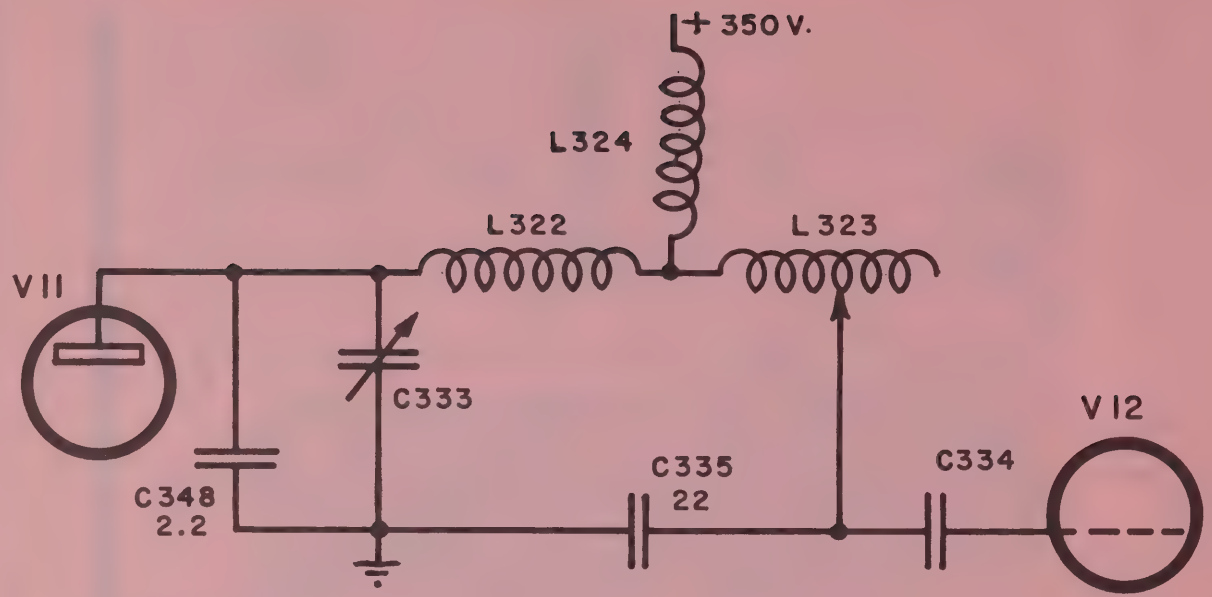


CHASSIS No. CN138B5 AND BELOW

CHASSIS No. CN138B6

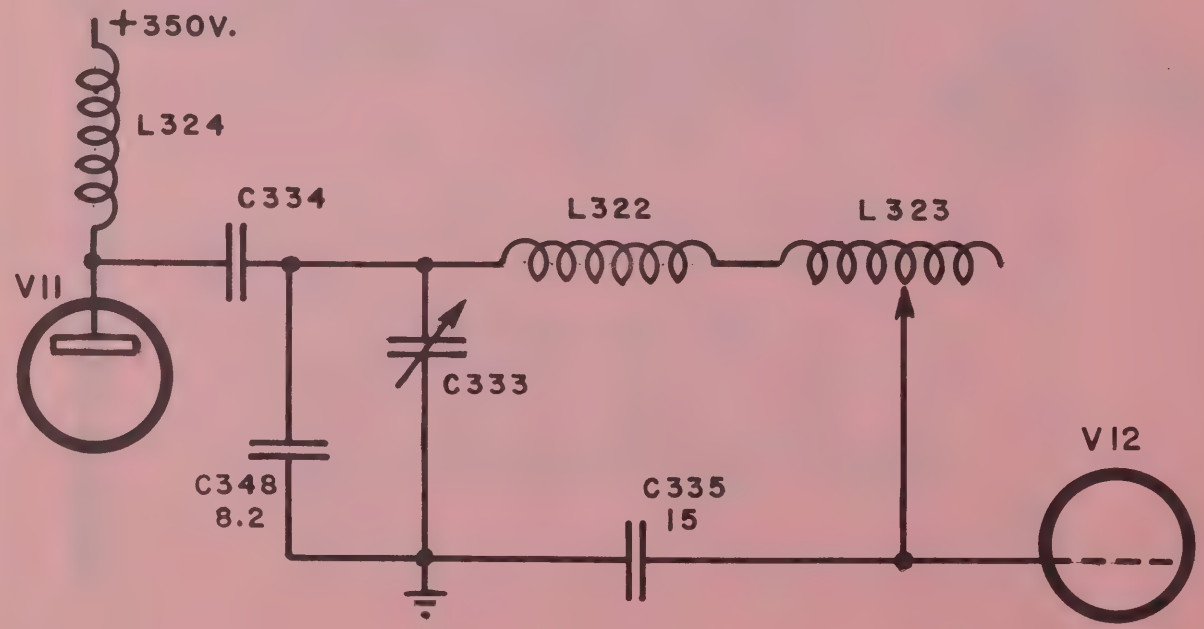


M-07248
Figure 9. Transmit/Receive Relay (V-501) Interconnections



CHASSIS No. CN138 B5 AND BELOW

CHASSIS No. CN138 B6



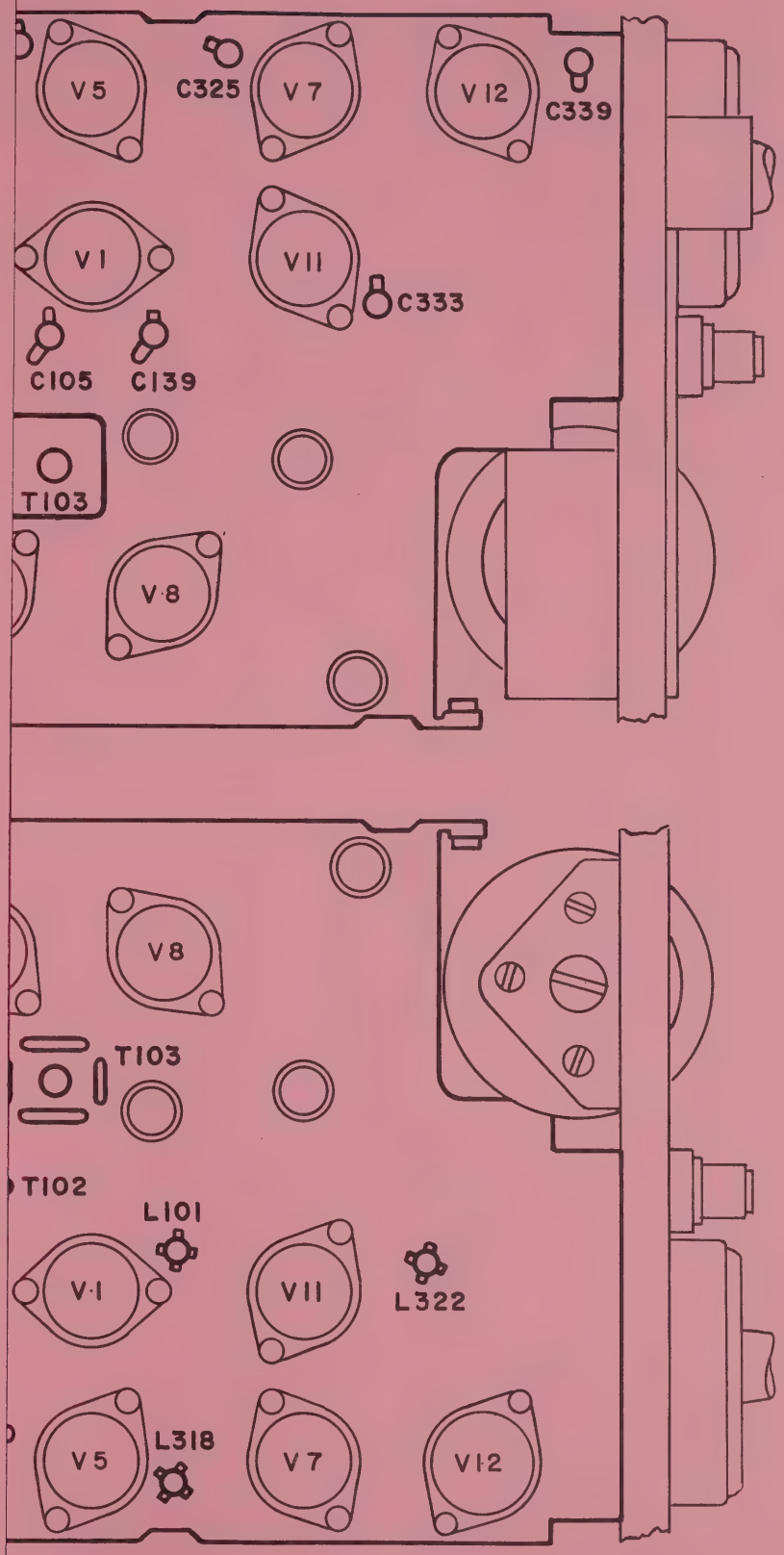
M-07249

Figure 10. Transmitter Interstage Coupling

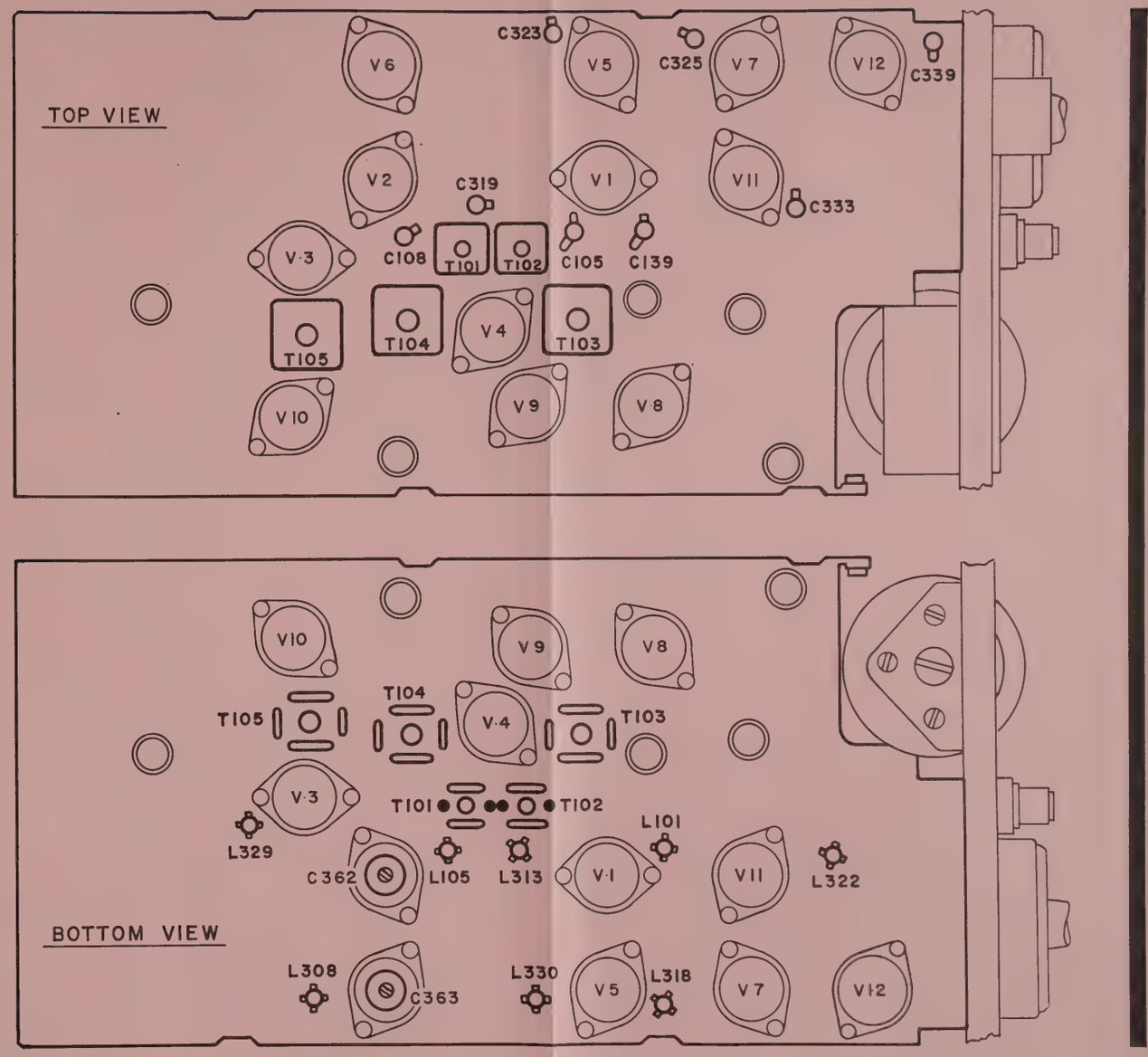
REPLACEMENT PARTS LIST.

The electrical components listed below are affected by the changes made in the chassis numbered CN 138-B6 and B7. The part numbers and item descriptions given below supersede the descriptions given in the original maintenance manual unless otherwise indicated. When ordering these parts from ***narco***, please list the chassis number and the source used to obtain this part number (supplements parts list).

SYMBOL	NARCO PART NO.	DESCRIPTION	STARTING WITH CHASSIS NUMBER:
		COMPONENTS CHANGED TO:	
C-335	21201-150	Capacitor, Cer. Tub., 15pf, 500V, ±10%	CN138-B6
C-348	21206-829	Capacitor, Cer. Tub., 8.2pf, 500V, ±.5pf, N470	CN138-B6
R-411	31135-153	Resistor, Carbon, 15K, ±10%, 1W	CN138-B6
		CHANGED FROM MYLAR TO POLYCARBONATE	
C-210	23092-125	Capacitor, Polycarbonate, 0.1μf, 75V, ±5%	CN138-B7
C-211	23092-125	Capacitor, Polycarbonate, 0.1μf, 75V, ±5%	CN138-B7
C-231	23092-63	Capacitor, Polycarbonate, 0.01μf, 75V, 10%	CN138-B7
C-232	23092-63	Capacitor, Polycarbonate, 0.01μf, 75V, 10%	CN138-B7
		CHANGED FROM MYLAR TO DIPPED MICA	
C-220	24045-472	Capacitor, Dipped Mica, 4700pf, 300V, ±5%	CN138-B7
C-221	24045-472	Capacitor, Dipped Mica, 4700pf, 300V, ±5%	CN138-B7
		CAPACITORS BELOW CHANGED IN CHASSIS NO. CN138-B7 ONLY (connected across T-103, T-104, T-105)	
C-118	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-125	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-126	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-131	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-135	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B6
		COMPONENTS ADDED	
C-451	21291-6	Capacitor, Cer. Disc, 0.1μf, 500 V GMV	CN138-B6
C-452	21291-6	Capacitor, Cer. Disc, 0.1μf, 500 V GMV	CN138-B6
R-425	31175-12	Resistor, Wirewound, 7K, ±10%, 5W	CN138-B6
R-426	31135-223	Resistor, Carbon, 22K, ±10%, 1W	CN138-B6
		ERROR ON SCHEMATIC, C-401 IS NOW:	
C-403	23085-271	Capacitor, Mylar, 0.047Ωf, 400V, ±10%	CN138-B6
		ADDITIONAL LISTING	
None	88156-101	Dial, Channel Selector, Tenths Mc/s	
None	04300	Dial, Decal, Tenths Mc/s channels	
None	88157-101	Dial, Channel Selector, Whole Mc/s	
None	04301	Dial, Decal, Whole Mc/s Channels	

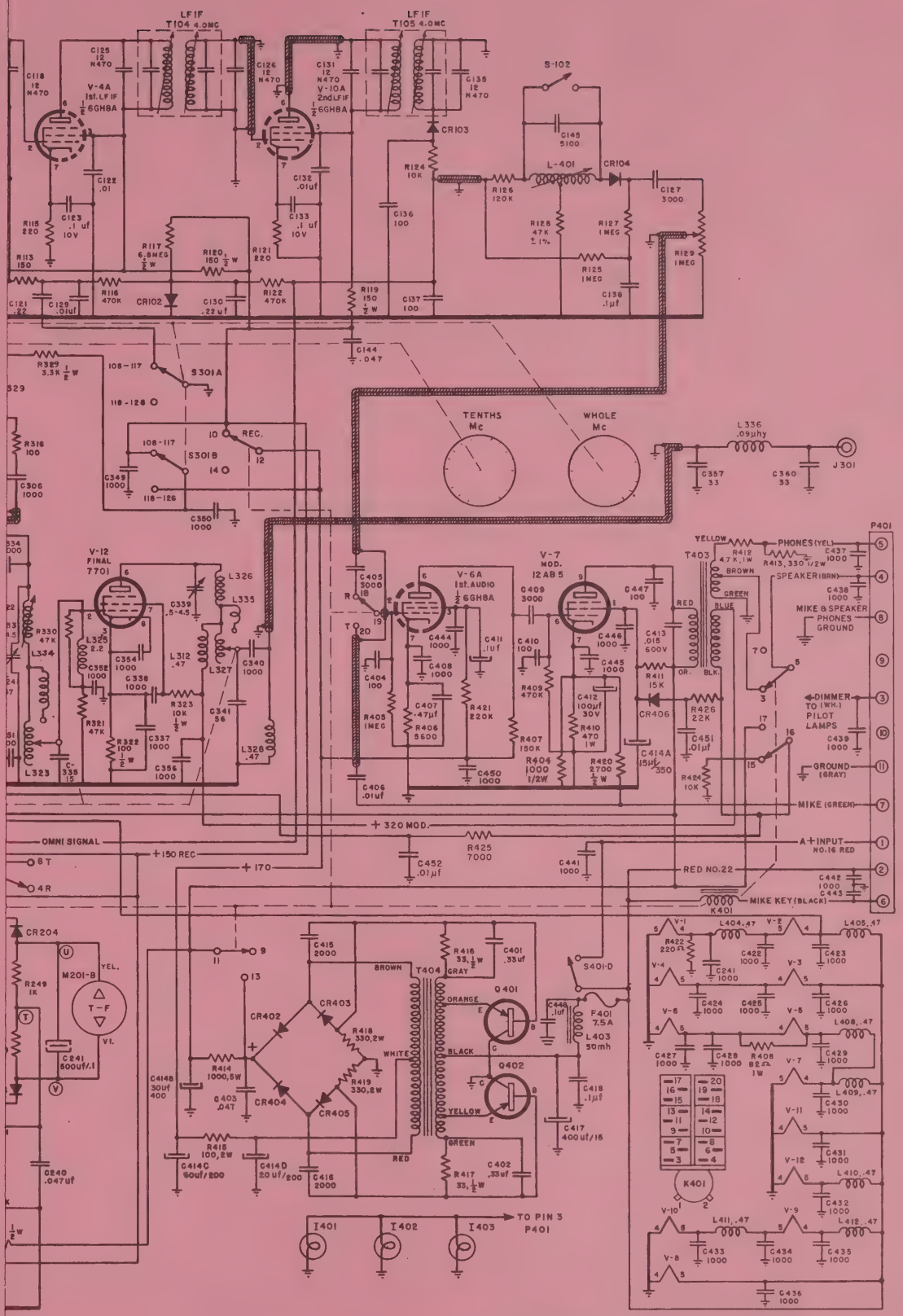


ls, Top and Underside of Chassis



P-07252

Figure 11. Location of Alignment Controls, Top and Underside of Chassis



1. ALL RESISTORS ARE ¼ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf)
3. ALL INDUCTANCES ARE MICRO HENRIES (μh)
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.

Figure 7b
SCHEMATIC, *narco* Mark III
for CN138-B7
PRODUCTION CHANGES
LOCATED ON APRON OF PAGE.

Since the manufacture of the original Mark-3 Omnigator, there have been various electrical and mechanical changes made to suit the customers requirements. Each electrical and/or mechanical change has been identified by assigning a new chassis number. Starting with the original manufactured Mark III, the chassis numbers range between CN 138-A1 and CN 138-B6. The original maintenance manual (3076-600) includes a schematic of the CN 138-A7 chassis, Supplement 1 includes a schematic of the CN 138-B5 chassis, and this Supplement includes a schematic of the CN 138-B7 chassis. A large percentage of the components are not affected by the chassis changes and the schematic can be used in these areas: if the chassis number does not agree with the schematic, use this list of chassis changes. The list given below can be used as a guide to interpolate the changes in components to arrive at the correct schematic.

CN 138-B6

The following changes were made to improve the transmitter performance under high ambient temperature and low line voltage operating conditions: V-11 plate circuit rewired for minimum detuning due to heat; CR-406, C-451 & C-452, R-425 & R-426 added, and R-411 value changed; from .01/500 to .047/400 to suppress power supply switching transients.

CN 138-B7

Components changed to improve temperature stability: OMNI C-210, C-211, C-231, and C-232 changed to polycarbonate; LOCALIZER—C-220 and 221 (V-8B plate circuit) changed to 24045-472 ±5%; and RECEIVER — C-118, C-125, C-126, C-131, and C-135 (connected across primaries of T-103, T-104, and T-105) changed from 21206-120 N470 to 21205-220 N330.

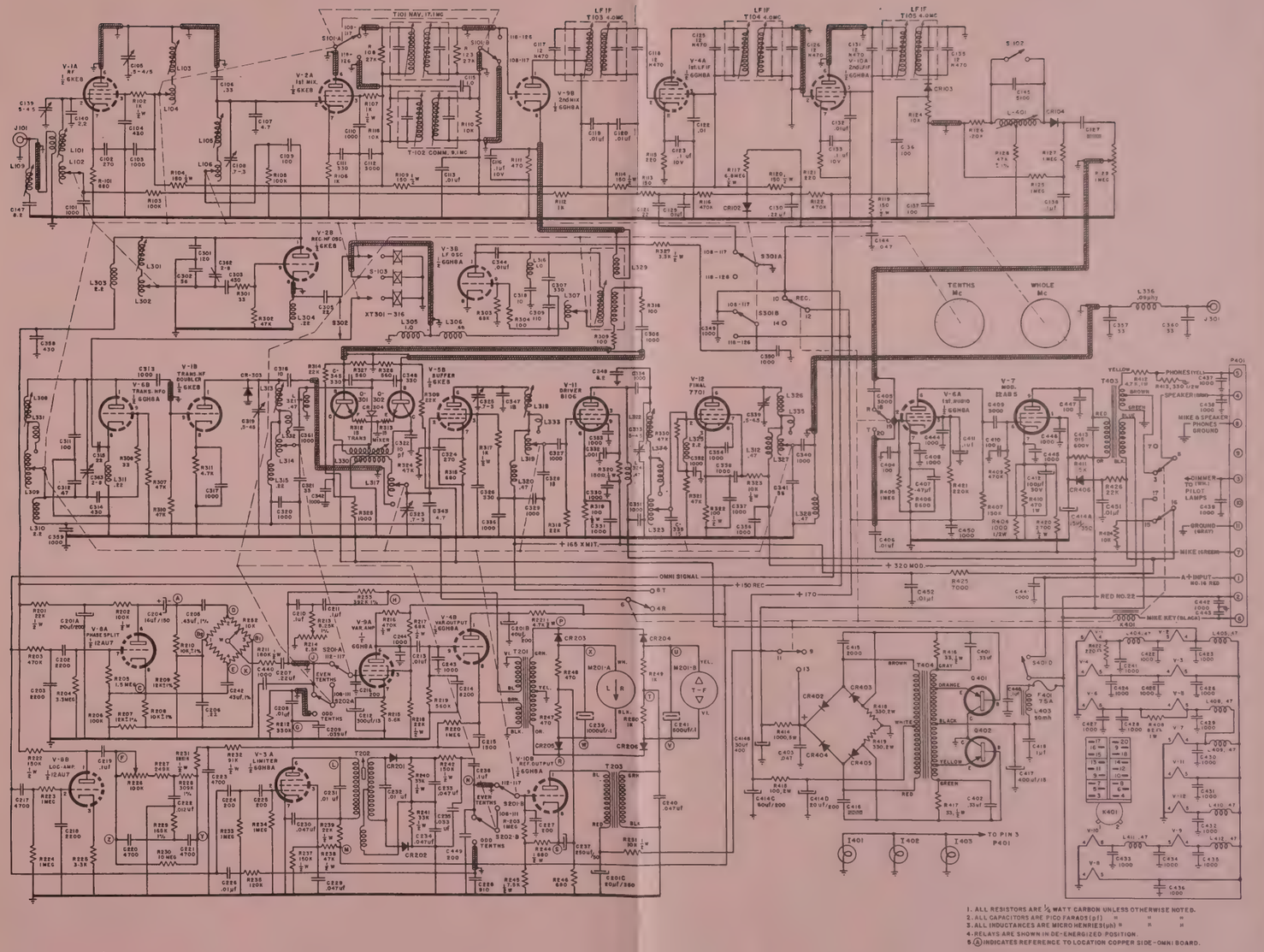


Figure 7b
SCHEMATIC, *narco* Mark III
for CN138-B7
PRODUCTION CHANGES
LOCATED ON APRON OF PAGE.

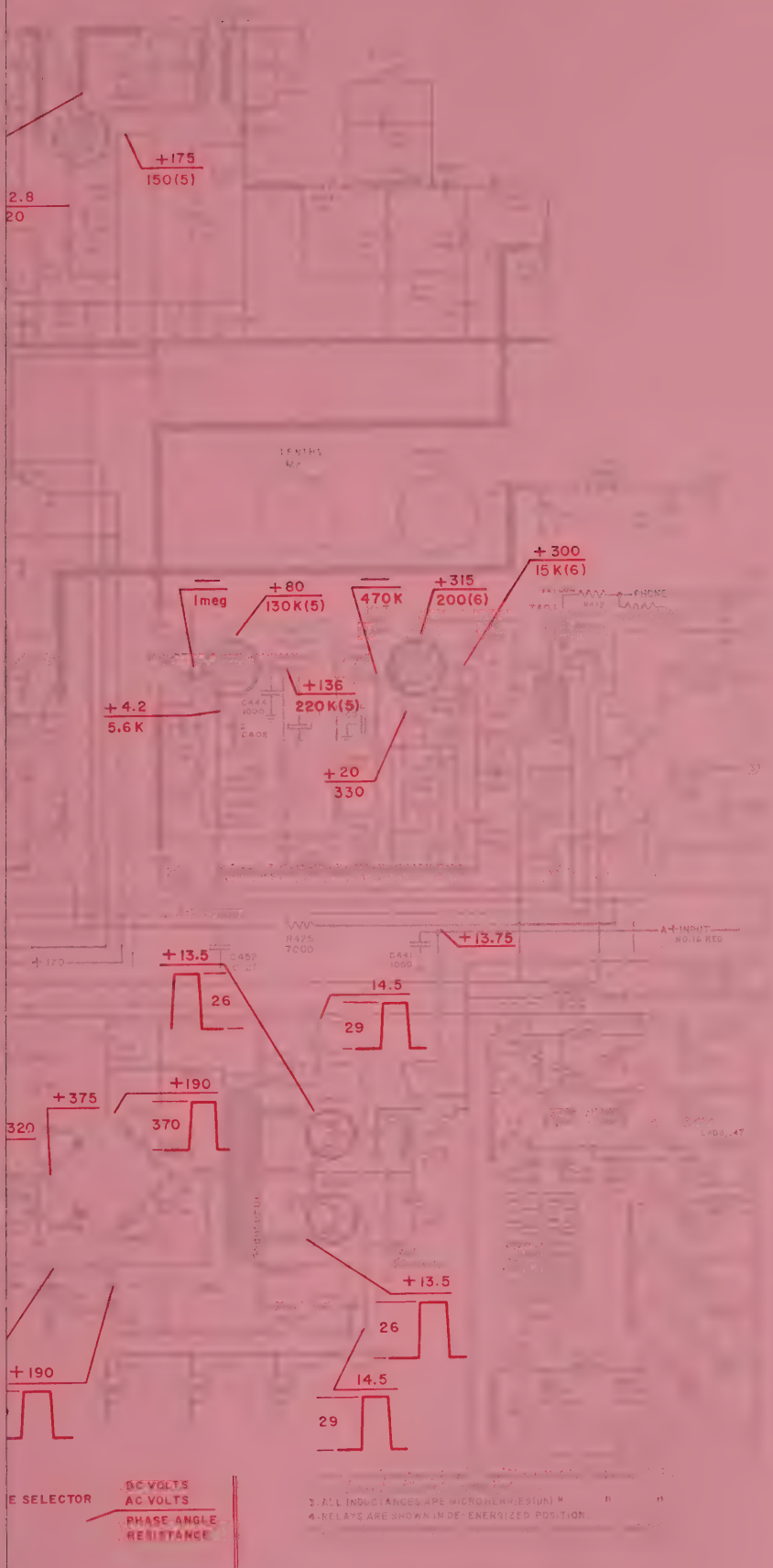


Figure 8b
SCHEMATIC with TEST DATA Overprint
narco Mark III
for CN138-B7

NOTES

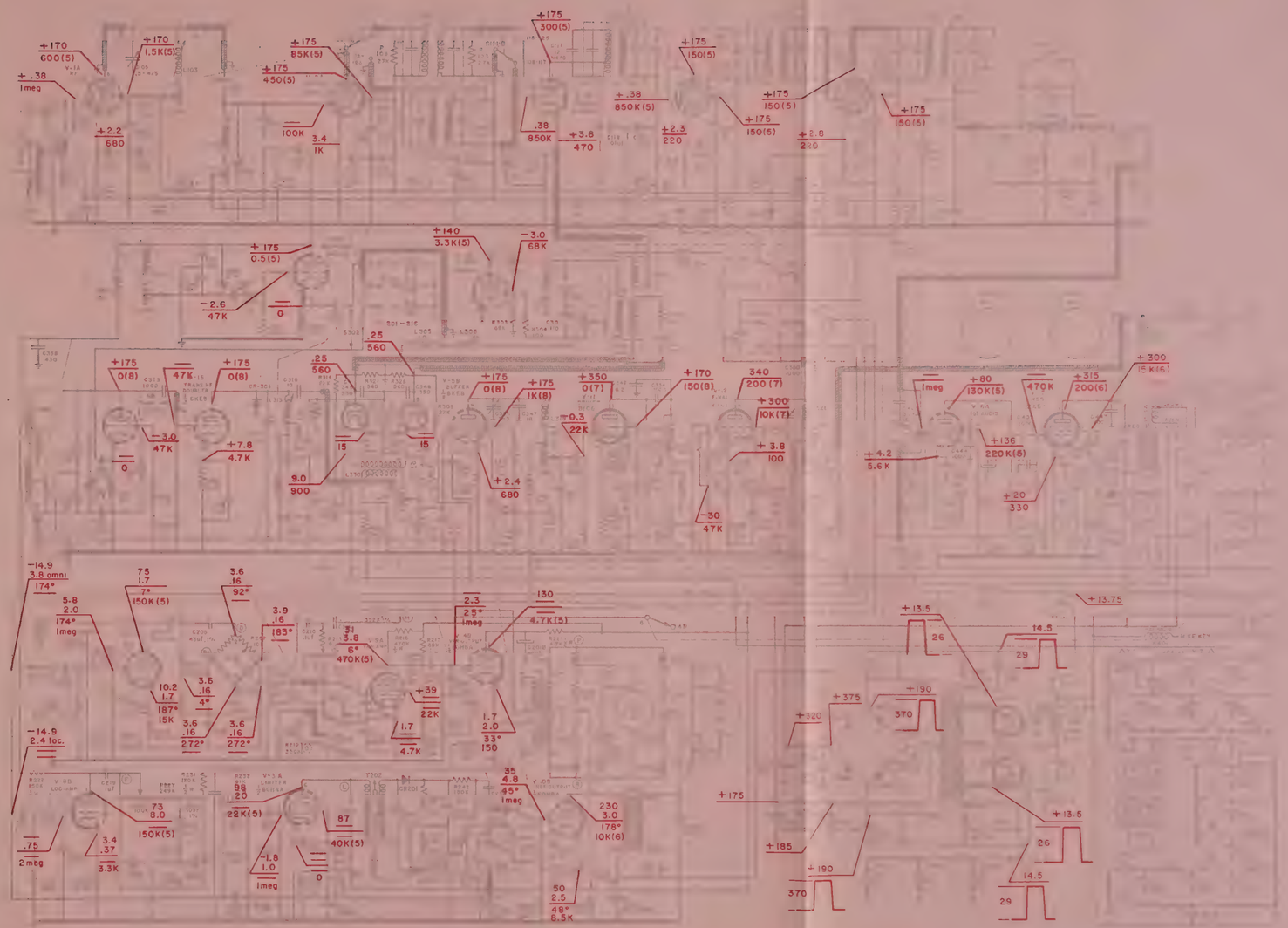

NOTES:
1. ALL VOLTAGES, RESISTANCES AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE NOTED.
2. ALL RECEIVER VOLTAGE MEASURED WITH VOLUME CONTROL FULL CCW, NO SIGNAL INPUT AND 13.75 V. DC APPLIED TO UNIT.
3. ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V.DC APPLIED TO UNIT.
DC VOLTS
RESISTANCE
4. ALL OMNI VOLTAGES MEASURED WITH 13.75 V.DC APPLIED TO UNIT, COURSE SELECTOR SET AT 0°, 500 µV. OMNI SIGNAL APPLIED.
5. MEASURED TO C414, SECTION "C".
6. MEASURED TO C414, SECTION "B"
DC VOLTS
AC VOLTS
PHASE ANGLE
RESISTANCE

Figure 8b
SCHEMATIC with TEST DATA Overprint
narco Mark III
for CN138-B7

How are we doing?

We at Narco welcome your comments and suggestions about the manuals, both good and bad. These are the best indicators of how informative the manual is to you, the ultimate user.

Should you have a helpful addition or find something that appears to be an error — fill in this slip and mail it right to the Technical Pubs Dept. and upon evaluation, we'll adjust the manual to include it.

All actions must include the following:

Manual Name .....

Manual No. ..... — ..... Supplement No. ..... (if any)

Page No. ....

From _____

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SUPPLEMENT 2

Place this sheet at the front of the original manual (MM-220) and Supplement 1 to indicate that Supplement 2 is included in this maintenance manual.

NARCO OMNIGATOR MARK III

MAINTENANCE MANUAL SUPPLEMENT No. 2

for CN138-B6 and CN 138-B7

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A.

3076-600
(MM—220)
Supplement 2

November, 1966

Supplement 2,
November, 1966

NARCO OMNIGATOR MARK III

MAINTENANCE MANUAL SUPPLEMENT No. 2

for CN138-B6 and CN138-B7

Remove the front cover sheet and place at the front of this Mark II Maintenance Manual to indicate that the manual has been updated to include all chassis changes up to CN138-B7. Supplement 2 can be inserted into the original manual on a page-by-page substitution or the complete supplement can be placed at the rear of the Mark III binder. Each new or revised paragraph in this supplement is identified with a vertical black bar at the outside margin of the paragraph or illustration.

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NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A.

3076-600
(MM—220)

November, 1966

INTRODUCTION.

This is Supplement No. 2 to the original Mark-III Maintenance Manual MM-220 (3076-600) dated September 1965. The supplement is intended to document the changes in Chassis No's. CN138-B6 and CN 138-B7 of the Mark-III Omnigator. The differences associated with all other chassis numbers (CN138-A to CN138-5) are described in Supplement 1, dated May, 1966.

The parts list in the supplement affects only the chassis indicated in the extreme right column. The items identified with chassis number CN138-B7. Please note that capacitors C-118, C-125, C-126, C-131, and C-135 apply to only the CN 138-B7 chassis since these components are associated with the actual I.F. transformers (T-103, T-104, and T-105) used on this chassis. If a new IF transformer is ordered, use the part number appearing in the original manual for both the transformer and the associated shunting capacitor. When ordering any of the above capacitors for any chassis other than CN138-B7, refer to the parts list in the original manual.

ADDITIONS AND CORRECTIONS

Unless otherwise indicated, the "CORRECTIONS" and "ADDITIONS" listed on Pages 57 and 58 of Supplement 1 are valid. The information given below must be added to the above changes to make a complete Mark-III documentation of chassis differences. This supplement includes the CN138-B7 schematic: for the CN138-B6 schematic, refer to the description of "PRODUCTION CHANGES" listed on the left apron of the B7 schematic (Figure 7b, Page 47).

Various components have been changed to: (1) improve transmitter performance under high ambient temperatures and low line voltage operating conditions; and (2) more efficiently suppress power supply switching transients. Other components have been changed to improve the temperature stability of the OMNI, LOCALIZER, and receiver circuits.

The photographs of Figures D,a and G,a have been revised to show the new components.

The R.F. Amplifier and Mixer Circuit alignment procedure has been added as paragraph 5-F,7: paragraph numbers 5-F,8 and 5-F,9 have been changed to suit.

The parts list on Page 93 has a complete list of the parts affected with the part numbers and descriptions necessary for ordering replacement parts. Where changes have been made to any pages, the affected paragraphs or illustrations have been identified by placing a black vertical bar at the margin edge. The reverse side of each page has been reprinted so as to permit inserting the revised pages into the original manual on a page-by-page substitution basis.

To locate the above pages, please refer to the Table of Contents on Page 75.

NOTE

In this maintenance manual any page number below 53 is located in the original manual; any page number between 55 and 73 is in Supplement 1; and any page number above 75 is in Supplement 2.

SECTION 2
INSTALLATION

2-A. INTRODUCTION.

The ***narco*** Mark III Equipment consists essentially of a single unit with front panel controls for direct manual operation by the pilot. It is normally installed in or near the instrument panel, for operating convenience. Installation usually involves primarily the permanent mounting of the case. Installation and removal of the unit proper is then accomplished by operating the latch at the front and connecting or disconnecting the cables at the rear.

To complete the installation the following items are required, if they are not already available. Two antennas (receive and transmit), headphones or loudspeaker or both, and a microphone. For details see the succeeding paragraphs in this section and the diagrams in Section 6.

2-B. UNITS & ACCESSORIES SUPPLIED.

1. ***narco*** Mark III PANEL UNIT with case.
2. CABLE Assembly, 54" long, for Power, Audio and Dimmer circuits, ***narco*** No. 90632-54.
3. Plug for Receiver Antenna, ***narco*** No. 41237-1.
4. FERRULE, for Plug (Item 3, above), ***narco*** No. 41237-2.
5. PLUG, for transmitter antenna, ***narco*** No. 41130-2

2-C. ACCESSORIES REQUIRED, but not SUPPLIED.

1. ANTENNA and Coaxial R.F. Cable for Receiver. A horizontally polarized dipole is required for Navigation Signals. See Items under 2-G., below.
2. ANTENNA and Coaxial R. F. Cable for Transmitter. A vertically polarized unipole over a suitable ground plane is recommended. See items under 2-G., below.
3. HEADPHONES or LOUDSPEAKER, or both if desired. Headphones, Z=300 to 1000 ohms. Loudspeaker, Z=3 to 6 ohms.
4. MICROPHONE. Low impedance type. A noise cancelling type is recommended.
5. FUSE or other D. C. Power Circuit protection rated at 15 amps.

2-D. OPTIONAL ACCESSORIES.

1. ANTENNA for Receiver.
   narco VRP-15A Pedestal Mounting Type, with 100 inch R. F. Cable ***narco*** Item No. EL-2056.
2. ANTENNA for Receiver.
   narco VRP-37 Tail Mounting Type, with 30 foot R. F. Cable and "Balun." ***narco*** Item No. EL-2060.
3. ANTENNA for Transmitter.
   narco VTP-17 Bent Rod Type, with 100 inch R. F. Cable ***narco*** Item No. EL-2057.
4. ANTENNA for Transmitter.
   narco VP-10 Broad Band Type, with Gasket, Hardware and BNC R. F. Cable Connector, but without R. F. Cable. ***narco*** Item No. EL-2028.
5. KIT, COOLING, ***narco*** Item No. EL-3076-500.
6. KIT, COOLING, Right Angle Type, ***narco*** Item No. EL-3076-501.
7. KIT, MODIFICATION, D.C. Converter. ***narco*** Item No. 3076-602 (may be required in chassis No. CN-138A12 and below when operating at extreme temperature).
8. KIT, FREQUENCY Change, Navigation Transmitter. ***narco*** Item No. EL-3076-503 (122.4, 122.5, 122.6, 122.7 Mc/s).

2-E. MECHANICAL INSTALLATION.

The ***narco*** Mark III equipment is essentially a single unit apparatus in a rectangular metal case. It is intended for Instrument Panel mounting, in a position convenient for direct manual operation by the pilot. The case is open at the front and rear, except for a vertical ground support strap at the rear. Bosses to accommodate mounting brackets are provided at the top, bottom and sides near the front and at the sides near the rear. See Figure 2, Page 28.

The case is normally installed permanently in the aircraft. It is to be fastened by brackets at the front and the ground support stud at the rear. If it is to be mounted in the instrument panel, it may be installed from the front or the rear. It is recommended that it be installed from the rear if possible. This is because, when it is installed from the front it is necessary to make a slightly larger cutout to accommodate the mounting bosses. When this is done the Front Trim Panel will not properly cover the cutout.

Mounting brackets are not supplied because the requirements vary considerably among the various installations. Brackets can be readily fabricated from metal sheet, or angle stock.

With the case properly installed the unit can be easily put in place. It is done by passing the short cable with a connector thru the case and then, when the unit is properly positioned, fastening it with the screwdriver operated latch. The latch is accessible thru a hole near the bottom center of the front trim panel. The access hole is covered with a snap-in button.

When the ***narco*** Mark III Equipment is to be mounted in a "stack" with other radio equipment, added cooling is of utmost importance for extended reliability. Cooling is desirable for single radio installations as well. An air inlet is located at the rear, near the lower center of the unit. A ***narco*** accessory kit (EL-2096) may be used to provide the necessary cooling.

Reference page 9 in original manual

2-F. ELECTRICAL CONNECTIONS.

All electrical connections are made to the rear of the Panel Unit Chassis. There are separate connectors for the receiver and transmitter antennas. The case is provided with a ground and support stud near the top of the vertical strap at the rear of the case. The strap also has a grounding jack near the center, which mates with a plug on the chassis. A good electrical connection must be made between the ground and support stud and the metal frame of the aircraft. The remaining connections are made via an eleven circuit connector, P-401, at the end of a short cable extending from the rear of the chassis. This connector mates with J-401 on the Cable Assembly, No. 90632-54, supplied with the equipment. See Figure 1, and Table A, page 27.

2-F,1. Primary Power

A wire, RED No. 16, about 10" long extends directly from the connector J-401. It should be connected to the aircraft 14 volt D.C. supply via suitable protection. See Item 2-C,5., above.

2-F,2. Dimmer Circuit.

A wire, WHITE No. 22, about 10" long extends directly from the connector J-401. It connects with the front panel lamps in the unit and may be connected to a common instrument-panel lamp-dimmer circuit. If no external connection is made the wire may be connected to terminal No. 2 in J-401. This provides +14 volts D.C. to the panel lamps, via the ON-OFF switch associated with the volume control on the Front Panel.

2-F,3. Power and Audio Cable Circuits.

A five wire cable, 54" long extends from J-401, along with the RED and WHITE wires noted under 2-F,1., and 2-F., above.

The BLUE, WHITE, BROWN and BLACK wires are properly connected to the mike and phone jacks supplied by the installer. The two jacks, for headphones and microphone, are normally mounted on the instrument panel at a place convenient for the pilot. See Table A, page 27.

The GREEN wire for the loud-speaker is unterminated. It may be extended if necessary, to reach the speaker.

2-G. ANTENNAS.

2-G,1. Receiving Antenna.

The full range and accuracy of the VHF omni-range system can be realized only when the airplane is equipped with the proper type of antenna. **For omni-range reception, a horizontal "V" dipole antenna is absolutely necessary. A vertical whip is definitely not satisfactory,** although it may appear to be when tried. Vertically polarized components are not radiated by the ground stations, but are produced by reflections from trees and similar objects. Therefore a vertical antenna may receive strong signals, but they are reflections and do not come directly from the ground station, giving rise to very unreliable bearings.

The ***narco*** Type VRP-15A horizontal "V" dipole antenna when used should be carefully installed preferably on top of the airplane behind the cockpit, and well away from the engine and propeller. An alternate type of antenna, ***narco*** Type VRP-37, is available for mounting on the upper part of the vertical stabilizer. The nose of the "V" dipole should face directly forward or aft, and the rods should be horizontal in level flight altitude.

The mast of the type VRP-15A antenna contains a matching "BALUN" which serves as an impedance transformer and as a means to connect a coaxial line to the balanced "V" dipole antenna. The type VRP-37 antenna is available with an external "BALUN" which attaches to the antenna rods. The other end of the "BALUN" is factory connected to the coaxial R.F. Cable which connects to the equipment. Either "BALUN" is made of coaxial R.F. Cable cut to critical dimensions which should not be altered. The sheath of the coaxial line to the receiver should be connected to the sheath of the "BALUN" cable and grounded directly to the metal surface of the aircraft. The VRP-15A mast includes this connection in its base. The VRP –37 Cable assembly is provided with a grounding lug for making this connection.

2-G,2. Transmitting Antenna.

The vertical rod type transmitting antenna, such as the ***narco*** VTP-17, should be mounted on a metal surface measuring at least 18 inches square to serve as a ground plane. Such a mounting surface is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface is available a piece of thin aluminum may sometimes be affixed flush with the fabric. This thin aluminum sheet or foil may be made to conform to the various curved surfaces to which it is mounted, but all cuts and seams should be along lines radiating from the antenna base. A ½ inch hole should be made in the center of this sheet for mounting the antenna. It is recommended that where necessary a metal reinforcing plate be provided to resist the bending load imposed by the slip-stream. The ***narco*** VTP-17 antenna should not be lengthened or shortened. It has been cut to the proper length for the most efficient radiation at the frequencies generated by the transmitter.

2-G,3. Antenna Cables.

The type VTP-17 transmitting antenna and the type VRP-15A receiving antenna are both available with 100 inch lengths of 52 ohm coaxial transmission line, type RG-58A/U. The alternate type of receiving antenna, type VRP-37, is available with 30 feet of RG-58A/U, 52 ohm coaxial transmission line with an attached "BALUN."

**Reference page 10
in original manual**

are retained by a notched black phenolic rod which must be removed to remove a switch section. To remove this retainer rod proceed as follows:

a. Remove the "D Washer" on the front of the metal front sub-panel, near the panel lamp I-402. See Photo B, Page 34.

b. Remove the two retainer springs at the top of the first and seventh vertical metal shields.

Note that the ⅜" O.D. shaft should be removed before removing the retainer rod and be replaced after the retainer rod is back in position, to avoid difficulty. The removal and replacement of a particular section will depend on its connections. The procedure must be determined by inspection.

5-C,6. Quartz Crystals.

All 16 Quartz frequency control crystals XT-301 thru XT-316 are assembled on a printed circuit board between the two switch sections S-302 and L-307/S-103.

The crystals are of the wire-in type. Removal and replacement must be done carefully. The procedure is to disconnect the lead to S-302, first and then, using printed circuit techniques, disconnect both leads from the printed circuit board. For details concerning printed circuit board. For details concerning printed circuit methods refer to 5-I., page 24.

5-D. ELECTRICAL MAINTENANCE.

5-D,1. Equipment Required.

1. R.F. Power Wattmeter, Bird Termaline Model 61, or equivalent.
2. DC Vacuum Tube Voltmeter (DC VTVM), RCA Senior Voltohmyst, with WG-301A Crystal Diode Probe, or equivalent.
3. AC Vacuum Tube Voltmeter (AC VTVM), Ballantine Model 300, or equivalent.
4. Low Impedance Microphone, with "push-to-talk" button.
5. MF/HF Signal Generator, General Radio Model 1001-A, or equivalent.
6. VHF Signal Generator, Hewlett-Packard Model 608-D, or equivalent.
7. Audio Wattmeter, General Radio Type 583-A, or equivalent.
8. Low Voltage D.C. Supply, 12-15V., dc at 10 to 15 amperes, Electro Products Laboratories, Model NFB, or equivalent.
9. Omni Signal Generator, Aircraft Radio Corporation, Model H-14A, or equivalent.
10. For phase angle measurement, four additional pieces of equipment are required, as indicated in the Test Setup Diagram, Figure 6, page 33.

5-E. OVERALL OPERATING CHECK.

5-E,1. Receiver.

Procedure:

a. Refer to the "Receiver Test Setup", Figure 4, page 32.

b. Connect the audio output (5 watts full scale), meter to the output cable Pins 4 and 8 on J-401/P-401.

c. Connect the AC VTVM to TL-20, terminal No. 5 (2 VAC full scale). Refer to Schematic Diagram, Figure 7, page 51 (Junction R-124 and C-137).

d. Connect the VHF Signal Generator to the antenna connector J-101. Set the Signal Generator for a 108.0 Mc. thru 126.9 Mc/s range, with 1000 cps, 30% modulation.

Normal Indications:

e. A signal of 3.5 μv maximum should produce a detector output of 1.3V RMS and 1.5 watts minimum (volume control at maximum) on all NAV channels.

f. A signal of 6 μv maximum should produce a detector output of 1.3V RMS and 1.5 watts minimum (volume control at maximum) on all COM channels, or 10 milliwatts (1 set phones, 600 ohms).

g. A signal of 1.5 μv maximum should produce 6db signal plus noise to noise at the speaker output in all NAV channels.

h. A signal of 2.5 μv maximum should produce 6 db signal-plus-noise to noise at the speaker output on all COM channels.

i. If normal indications are not obtained, refer to the procedures outlined in the paragraphs under 5-F., below.

5-E,2. Transmitter.

Procedure:

1. Refer to the "Transmitter Test Setup", Figure 5, page 32.
2. Connect the R.F. Wattmeter to J-301, the transmitter antenna connector, in place of the antenna.
3. Place the Channel Selector on any COM channel, 118.0 thru 126.9 Mc/s.
4. With the "Push-to-talk" Microphone connected, activate the transmitter.
5. Check all transmitter channels over the complete range of 118.0 thru 126.9 Mc/s.

Normal Indication:

Reference page 21 in original manual

Power output should be a minimum of 2 watts on all channels without modulation. Voice modulation should cause a slight increase in the output power.

If a normal indication is not obtained, refer to the procedures outlined in the paragraphs under 5-G., below.

5-E,3. OMNI and Localizer Circuits.

a. Connect the test equipment to the receiver as shown in Figure 6, page 33.
b. Set the receiver Channel Selector dial to an OMNI channel.
c. Set the R.F. Signal Generator output at 500 microvolts. Set the OMNI course selector at 0° with the modulation switch on the OMNI position.
d. Set the receiver course selector dial to 0°. The Left-Right needle should read center, and a full "TO" flag should show. Rotate the Omni signal generator to 180° and note any Left-Right needle swing. Full "FROM" flag should show.
e. Check course selector heading against OMNI Signal Generator headings. They should agree within ±4°.
f. Set Omni signal generator for localizer signal output. Set the receiver dial for an odd tenth megacycle channel 108.1 thru 111.9 Mc/s.
g. Check centering of left-right needle. A change of 4 db localizer signal will give deflection to the edge of the color sections.

5-F. RECEIVER ADJUSTMENT PROCEDURES.

5-F,1. High Frequency Oscillator (HFO).

Connect the DC VTVM as shown in the Receiver Test Setup, Figure 4, page 32. The drive at Pin 9 of V-2B should be –3.0 VDC minimum. If it is less, Select 126 Mc/s and peak L-301 for maximum negative voltage, then Select 118 Mc. and peak C-304 for maximum negative voltage. Repeat the procedure until the drive is approximately flat across all Mc/ channels.

5-F.2. Low Frequency Oscillator (LFO).

Connect the DC VTVM as shown in the Receiver Test Setup, Figure 4, page 32. The drive at Pin 9 of V-3B should be –3.0 V. dc minimum on any Tenths Mc/s channel. If it is less, Select the 0.0 channel and peak L-329 for maximum negative voltage. The remaining tenths Mc/s positions 0.1 thru 0.9 should then all be in tune.

5-F.3. Intermediate Frequency (IF) Alignments.

In the following several alignment procedures, the results of the signal inputs and tuning procedures will be observed on the AC VTVM connected at the junction of R-124 and C-137. This is the output of the detector CR-103, at TL-20, terminal No. 5. See Photo D, page 36 and the Schematic Figure 7, page 51.

Reference page 22 in original manual

5-F,4. Low Frequency I.F.

Disconnect all components from Pin 9, V-9B, the grid of the second mixer. Connect the MF-HF Signal Generator to Pin 9, V-9B. Terminate the Generator with a 47 ohm resistor and feed the grid through a .047 μf capacitor. A 4.0 Mc/s signal at 300 μv, 400 cps, 30% modulation should produce 1.3 volts ac at the detector. If it does not, check the tuning of the LF IF transformers T-103 through T-105. Tune the primary and secondary slugs of all transformers for maximum output at the detector, CR-103. Make sure all cores are on the outer peak.

Reconnect all components to Pin 9, V-9B.

5-F,5. NAV High Frequency I.F.

a. Set the Channel Selector to 108.5 Mc/s.
b. Disconnect all components from Pin 2, V-2A and connect the Signal Generator to Pin 2. Terminate the Generator with a 47 ohm resistor and feed the grid through a .047 μf capacitor. (Refer to Crystal Frequency Table I, page 29.) Note the HF IF Frequency for the 0.5 Mc/s channel.
c. Set the MF/HF Signal Generator to the Selected frequency. A level of 20 μv (400 cps, 30% modulation) should produce approximately 0.5V. ac at the detector output, CR-103.
d. Now set the tenths Mc/s dial to the 0.0 channel. Set the Generator to the proper frequency and repeak the primary and secondary by adjusting the cores for maximum output at the detector, CR-103.
e. Reset the tenths Mc/s dial to the 0.9 channel. Reset Generators to the proper frequency and again repeak for maximum output at the detector, CR-103.
f. Check the output at the 0.0, 0.5, and 0.9 Mc/s points. Output at the 0.0 and 0.9 Mc/s points should be approximately the same. Output at the 0.5 Mc/s channel should be about 1 db below the end point values.

5-F,6. COM High Frequency I.F.

a. Set the Channel Selector to 118.5 Mc/s and repeat Steps c., thru f., under 5-F,5., above, using the proper HF IF and adjust T-102 to obtain approximately flat output across all tenths Mc/s channels.
b. Reconnect all components to Pin 2, V-2A.

5-F,7. R.F. Amplifier and Mixer Circuits.

Refer to Figure 4 for the receiver test setup and connect the test equipment as described in 5-E, steps b, c, and d. Refer to Figure 11 for location of alignment controls and proceed as follows:

a. Set the Channel Selectors and Signal Generator frequency selector to 126.5 Mc/s (6.0 μv output level).

b. Peak L-105, L-103, and L-101 for maximum output at the VTVM and/or the audio output meter.
c. Repeat step b. in the same order since there is some interaction between these circuits.
d. Set the Channel Selectors and the Signal Generator frequency selector to 108.5 Mc/s (6.0 μv input).
e. Peak C-108, C-105, and C-109 for maximum output at the VTVM and/or the audio output meter.
f. Repeat step e. in the same order since there may be some interaction between these circuits.
g. Set the Channel Selectors and the Signal Generator frequency selector to 126.5 Mc/s and repeat step b. and c. since there may be come interaction between the low and high ends of the band.
h. Set the Channel Selectors and the Signal Generator frequency selector to 108.5 Mc/s and repeat steps e. and f.

5-F,8. Audio Circuits.

As noted under 5-E,1.,f, above a signal of 6 microvolts to the input of the receiver should produce an audio signal of 1.3 volts at the output of the detector, CR-103, on all COM Channels. With the receiver volume control at maximum the above signal should provide a 0.25 Volt signal at the grid of the first audio amplifier V-6A, terminal 2. This in turn should provide a signal of 15 volts at the grid of the output amplifier V-7, terminal 6.

With the above condition the audio level across the RED and ORANGE leads of T-403 should be about 150 volts. This should provide about 2.5 watts of audio power to a loud speaker having an impedance between 3 and 6 ohms.

5-F,9. Automatic Volume Control (AVC).

The AVC threshold is that point at which the AVC line starts to go negative as a result of a signal increase.

It may be measured at TL-20, Terminal 3. See Photo D, page 36.

The AVC line should start to go negative when the detector, CR-103, output level reaches 1.3V., ac $\pm$0.1 V., ac. The detector output level may be measured at the junction of R-124 and C-139, which is located on TL-20, Terminal 5. See Photo D, page 36.

The AVC threshold is controlled by the value of R-117. One end of the R-117 may be located on TL-20, Terminal 3.

The AVC characteristic is such that a change of signal input level from 10 μv to 10,000 μv should produce a maximum of 4 db increase in the audio output signal.

5-G. TRANSMITTER ADJUSTMENT PROCEDURES.

5-G,1. High Frequency Oscillator (HFO).

With the equipment connected as shown in the Transmitter Test Setup Diagram, Figure 5, page 32 refer to the Schematic Diagram, Figure 7, page 51. The drive at the grid of V-6B, Pin 9, should be –3.0 V.dc minimum on all COM Mc/s channels. If it is less, select 126 Mc/s and peak L-308 for maximum voltage. Then, select 118 Mc/s and peak C-310 for maximum voltage. Repeat this procedure until the drive is approximately flat over all Mc/s channels.

5-G,2. High Frequency (HF) Doubler.

The rf voltage at the grid of the H.F. Doubler should be approximately 3 volts RMS. It may be measured with the DC VTVM and its Diode Probe.

5-G,3. Low Frequency Oscillator (LFO).

The drive at the grid of V-3B should be at least –3.0 V. dc measured through a 1 megohm resistor in series with the VTVM. If it is less, Select the 0.0 Kc/s channel and peak L-329 for maximum negative voltage. The remaining tenths Mc/s position 0.1 thru 0.9 should then all be in tune.

5-G,4. Balanced Mixer.

The Balanced Mixer involving Q-301 and Q-302 receives energy from both the transmitter HF Doubler, -1B, and the common LFO, V-3B. Energy levels from the HF Doubler and LFO are quite low. They can be measured with the DC VTVM and its Diode Probe.

a. To measure the level from the LFO de-activate the HF Doubler by removing the tube V-6. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.15 volt RMS.

   If the voltage is too low the adjustment of L-313 should be peaked at 126.5 Mc/s and C-319 should be peaked at 118.5 Mc/s. See Photo D, page 36. These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

   Replace V-6 as soon as the measurement is completed.

b. To measure the level from the HF Doubler deactivate the LFO by removing the tube V-3. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.25 Volt RMS.

   Replace V-3 as soon as the measurement is completed.

c. The combined voltages from the LFO and the HF Doubler at the bases of Q-301 and Q-302 should be alike and approximately 0.5 Volt RMS.

5-G,5. Buffer.

The buffer stage, V-5B, receives its grid from the output of the Balanced Mixer, Q-301 and Q-302. This drive is at the desired transmitter output frequency, but at a low level. It may be measured with the DC VTVM and its Diode Probe, at terminal 2 of V-5B. The voltage should be about 1.0 Volt RMS.

If the voltage is too low L-330 should be peaked at 126.5 Mc/s nd C-323 a 118.5 Mc/s. See Photo D. These adjustments should be repeated until the rf level is approximately uniform over the tuning range.

Reference page 23 in original manual

NOTE

Allowance should be made for some loading effect of the probe connection. This may be done by re-checking the peaking with the probe connection on the Driver grid (V-11, terminal 7).

5-G,6. Driver.

The voltage at the grid of the driver, V-11, pin 7, should be –0.3 V. dc minimum. If it is less, proceed as follows:

1. Select the 0.5 Mc/s position on the tenths Mc/s Selector.
2. Select the 126 Mc/s position on the Mc/s Selector and peak L-313, L-330, and L-318 for maximum negative volts at Pin 7 of V-11 (through a 1 meg-ohm resistor).
3. Select the 118 Mc/s position on the Mc/s Selector and peak C-319, 323 and C-325 for maximum negative volts at Pin 7, V-11.
4. Repeat the above procedure until the drive is approximately flat across all Mc/s channels.

5-G,7. Final Amplifier.

The drive at junction of L-325, R-321, R-330, and C-352 should be at least –45 VDC. If it is less, select the 126 Mc/s channel and peak L-322 for maximum negative volts at the junction of the above components. Then, select the 118 Mc/s channel and peak C-333 for maximum negative volts. Repeat the procedure until the drive is approximately flat across all Mc/s channels.

5-G,8. Modulator.

The transmitter final output amplifier V-12, a type 7701 tube, is modulated by the common Audio Amplifier tube, V-7, via a winding on the output of the transformer T-403.

The audio voice signal from the microphone goes via C-406 to the grid of the first audio stage, V-6A, terminal 2. The level at this point should be about 0.25 volts audio. The level at the grid of V-12, terminal 6, should be about 15 volts audio.

With the above condition the audio level across the RED and ORANGE primary leads on T-403 should be about 150 volts. This represents approximately 5 watts of audio modulation power.

5-H. OMNI CIRCUITS.

5-H,1. Reference Channel Alignment.

To Check the Omni Reference Channel Alignment proceed as follows:

a. Connect the test equipment to the receiver as described under 5-E., above.
b. Connect an oscilloscope to Pin 9 of V-10B.
c. Locate the discriminator transformer T-202. Adjust the primary and secondary cores for maximum undistorted signal as noted on the scope. If, in the process of peaking the primary and secondary slugs, the TO-FROM flag changes direction, you have tuned on a false peak. Look for another peak which will give maximum amplitude without causing the TO-FROM flag to change direction. This is the proper setting.

Reference page 24 in original manual

5-H,2. Variable Phase Alignment.

a. Set the receiver course selector dial to 270°. Set the OMNI Generator dial to 270° also.
b. Located the OMNI Zero Set Control (R-214) marked "OMNI" Photo E page 32. Turn this control to center the Left-Right Indicator.
c. Change the OMNI Generator setting 180° (to 90°) and note if there is any reciprocal error. If there is an error greater than ±4° the meter rectifier balance should be checked.

5-H,3. Rectifier Balance.

To balance the Left-Right Indicator rectifiers proceed as follows:

a. Locate the R-247 & R-248 (470 ohm) on the OMNI board. Photo G, page 38.
b. Compensate either R-242 or R-248 whichever one will allow the meter to center (compensating resistor values of 22K ohm or less, depending on the amount of reciprocal error.)
c. Recheck "TO" course and "FROM" course and adjust compensating resistor value for minimum amount of error.

5-H,4. Localizer Centering Adjustment.

a. Set the receiver to a proper Localizer channel and properly set up the OMNI Signal Generator for a Localizer Signal. Refer to 5-E,3., above.
b. The only compensation available for centering the Left-Right Indicator is the adjustment marked "LOC", See Photo E, Page 37. Turn this adjustment (R-226) to center the needle.

5-I. PRINTED CIRCUIT METHODS.

Printed circuits are very reliable and serviceable when they are properly designed, installed and maintained. However, they may be easily damaged by improper maintenance procedures. The following methods if carefully observed will insure satisfactory repairs.

5-1,1. Tools required.

a. Soldering Iron, small, 40 watts or less.
b. Small Long Nose Pliers.
c. Small Angle Cutters.
d. Small Stiff Bristle Brush, or "solder sipper."
e. Sharp pointed instrument (scriber).

CAUTION:

NEVER place the soldering iron directly on the printed circuit if it can be avoided. EXCESSIVE HEAT will raise the circuit from the board.

5-1,2. Replacement of Small Components.

a. Cut the leads and remove the component from the board.
b. Using the small soldering iron and long nose pliers, lift the remaining ends of the component from the board.
c. With the tip of the iron open the holes in the board by drawing the solder away from the holes.
d. Bend the leads of the replacement component and fit them through the holes (observing polarity, if any.
e. Cut off any excess length.
f. Observe that contact surfaces are clean, then resolder.

SECTION 6
ILLUSTRATIONS

6-A. INTRODUCTION.

Most of the various Tables, Diagrams and Photos except the Electrical Circuit Schematics referred to in the preceding sections have been collected in this section for convenient reference. This arrangement was chosen in preference to the arrangement where the illustrations are located on or near the pages where the subject is discussed. Such an arrangement tends to be inconvenient and confusing when the illustration is needed to cover more than one subject.

The arrangement of this manual is such that wherever it is practical the illustrations are upright with respect to the text, for convenient use.

Section 7, Replacement Parts, follows this section.

Section 8, Schematic, follows the Replacement Parts section as the last item in the Manual. The Schematic is in the form of a two-page "pullout" sheet which can be used while the pages of the text, illustrations, or parts list are open for use.

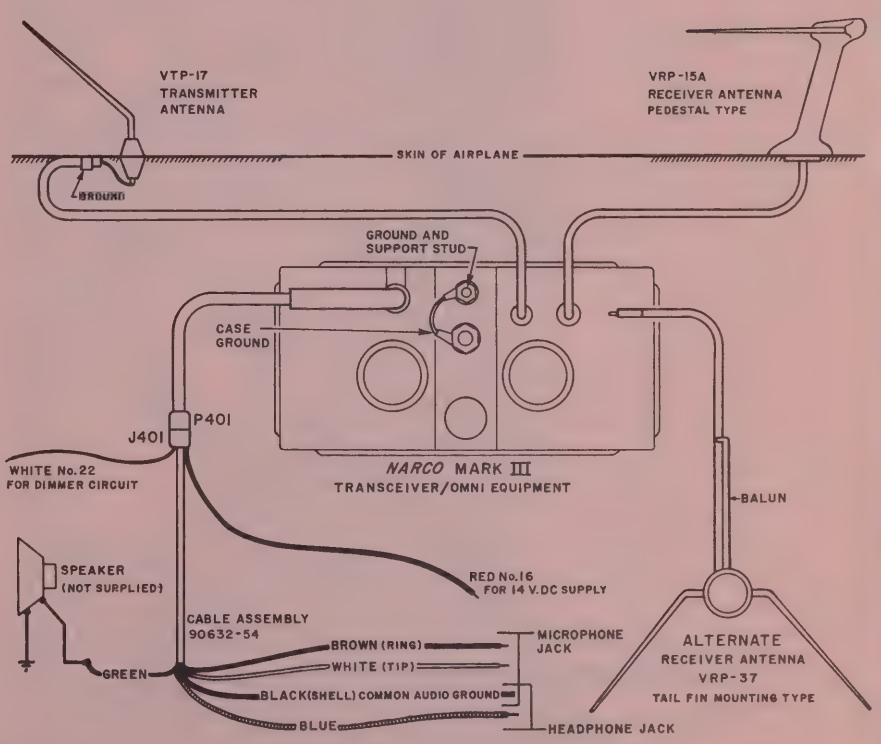
6-B. TABLES and DIAGRAMS.

TABLE A

POWER and AUDIO
CABLE CIRCUITS.

J-401/P-401 Connections

Term. No.	Wire	Circuit
1	RED, #16, 10" Long.	D.C. Supply, +14 Volts.
2	.....	+14 Volts, via ON-OFF Sw.
3	WHITE, #22, 10" Long.	External Dimmer Circuit
4	GREEN, in Cable.	For Loud-speaker.
5	BLUE, in Cable.	For Head-phones.
6	WHITE, in Cable.	T-R Control, (Mic. Jack Tip)
7	BROWN, in Cable.	Microphone (Mic. Jk. Ring)
8	BLACK, in Cable.	Ground for Mic. and Phones.
9	.....	No Conn.
10	.....	No Conn.
11	.....	Ext. Gnd. (optional)



AW-666

Figure 1a
Equipment Interconnections
narco OMNIGATOR Mark-III

Reference page 27 in original manual

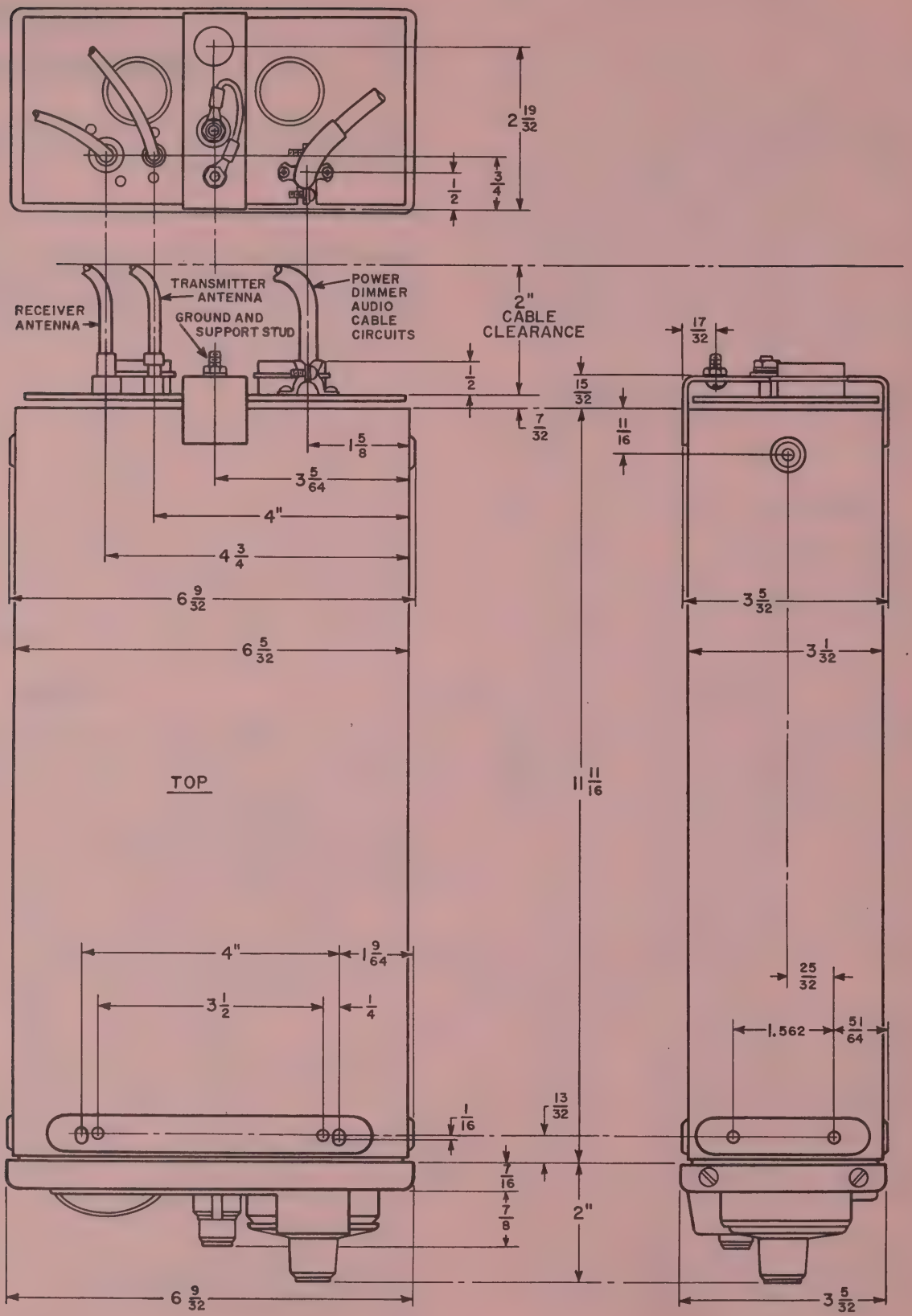


Figure 2.
Mechanical Installation Dimensions
narco OMNIGATOR Mark-III

Reference page 28 in original manual

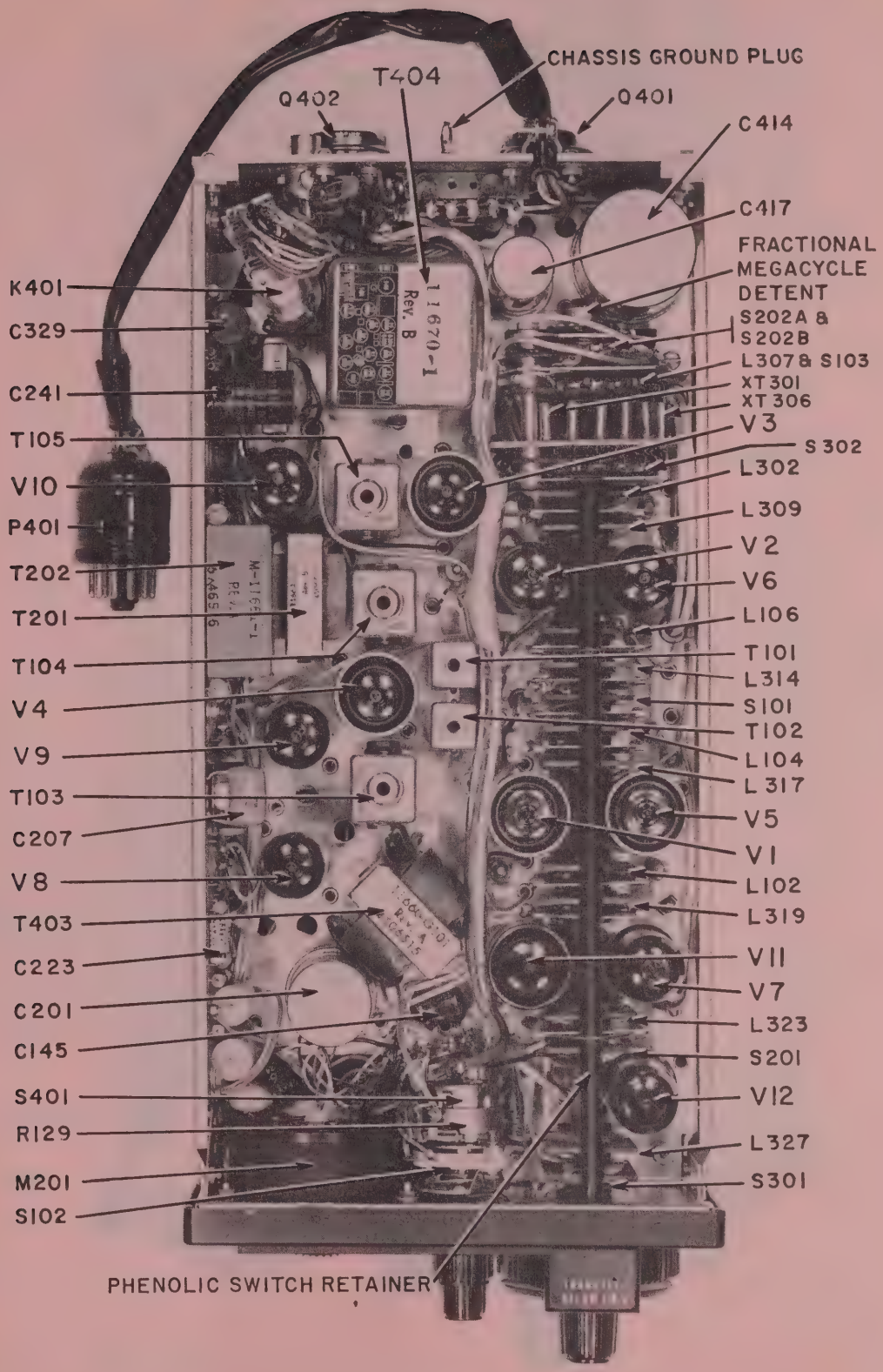
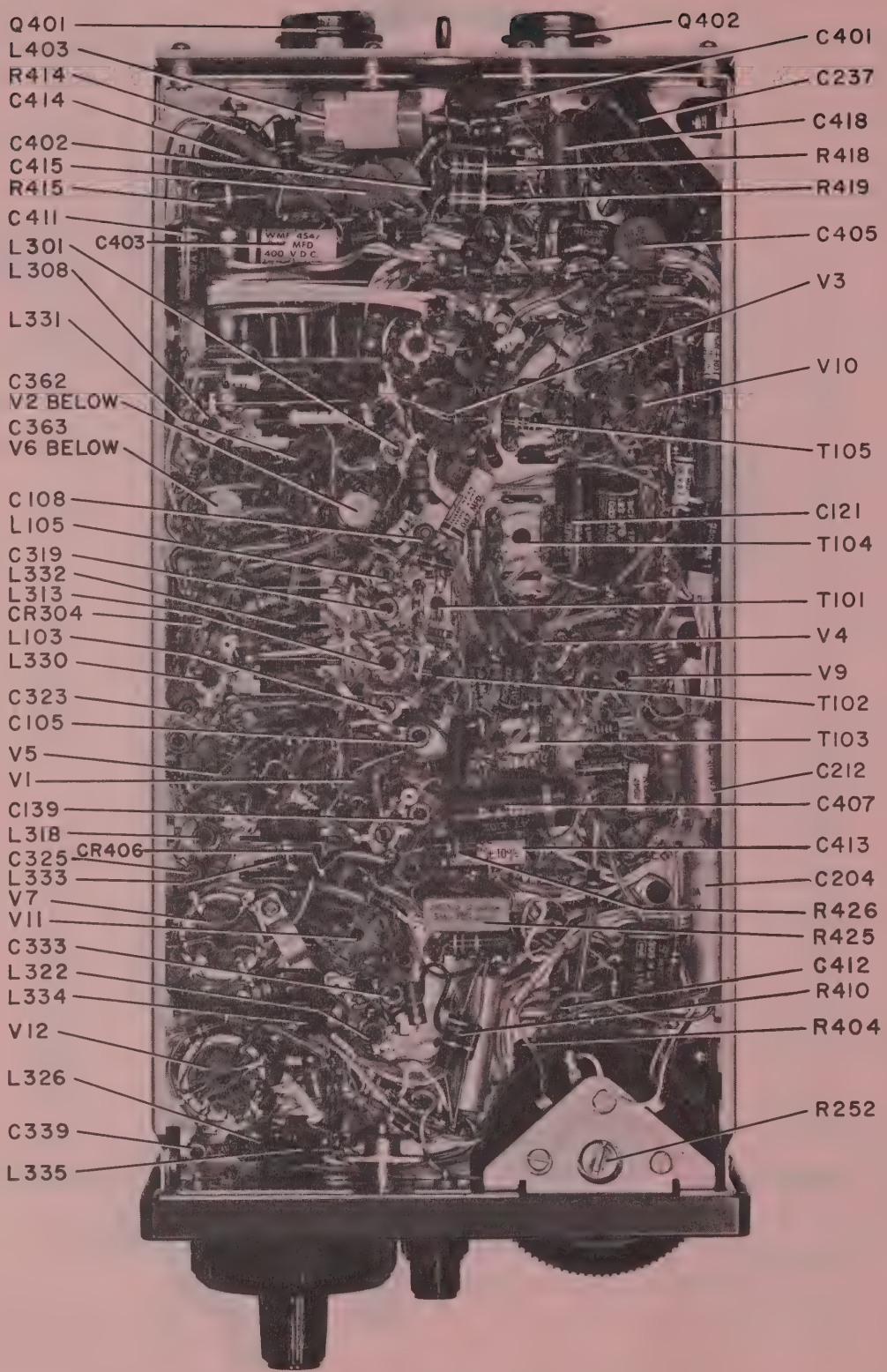


Photo Ca.
TOP VIEW, *narco* Mark-III Equipment.

Reference page 35 in original manual and page 65 in Supplement 1

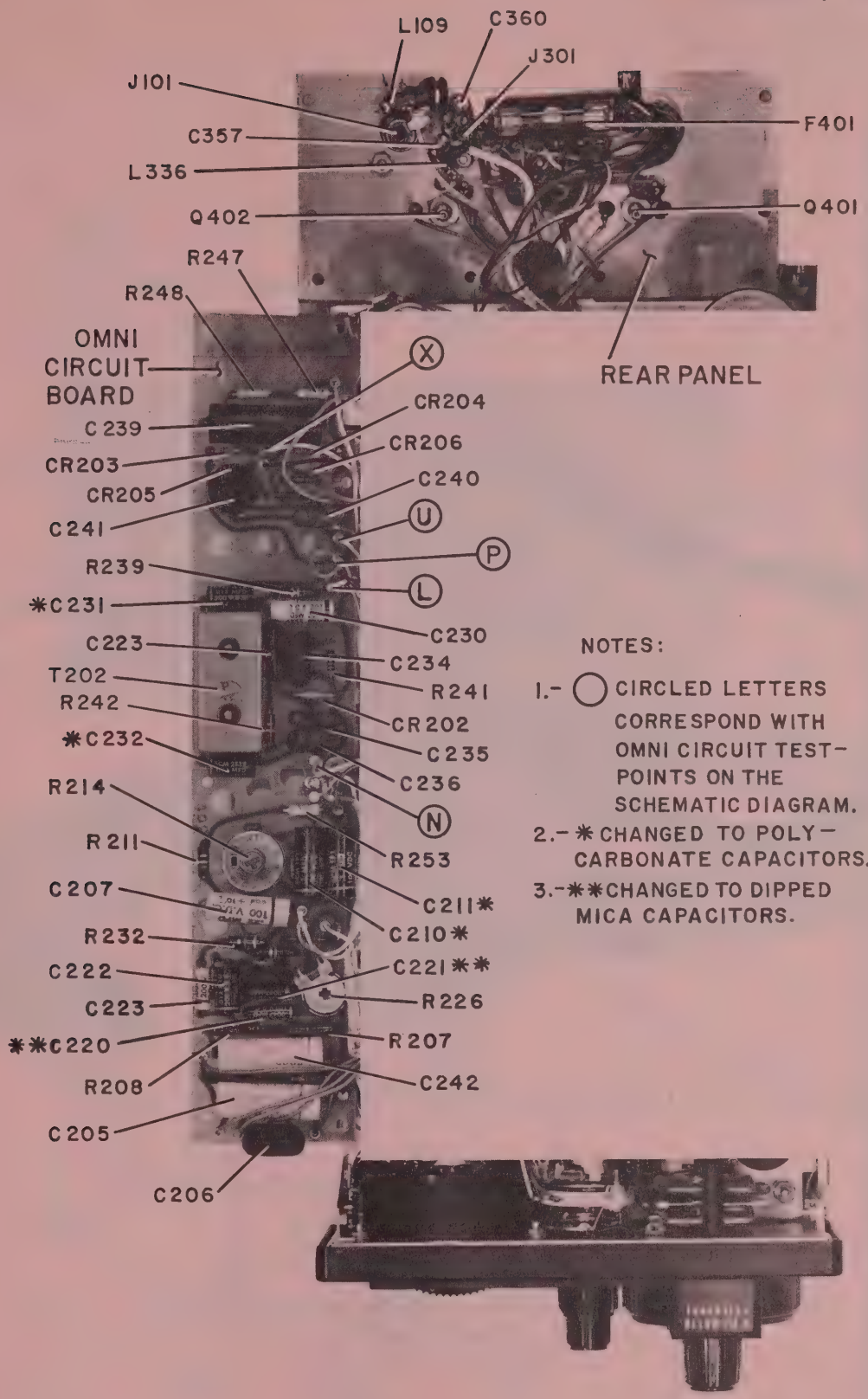


NAR-568

Photo Db

BOTTOM VIEW, *narco* Mark-III Equipment.

Reference page 36, in original manual and page 66 in Supplement 1



NOTES:

1.- ◯ CIRCLED LETTERS CORRESPOND WITH OMNI CIRCUIT TEST-POINTS ON THE SCHEMATIC DIAGRAM.

2.- * CHANGED TO POLY-CARBONATE CAPACITORS.

3.- ** CHANGED TO DIPPED MICA CAPACITORS.

NAR-569

Photo G,b

OMNI BOARD (Component Side), and REAR PANEL
narco Mark-III Equipment.

Reference Page 38, in original manual and page 67 in Supplement 1

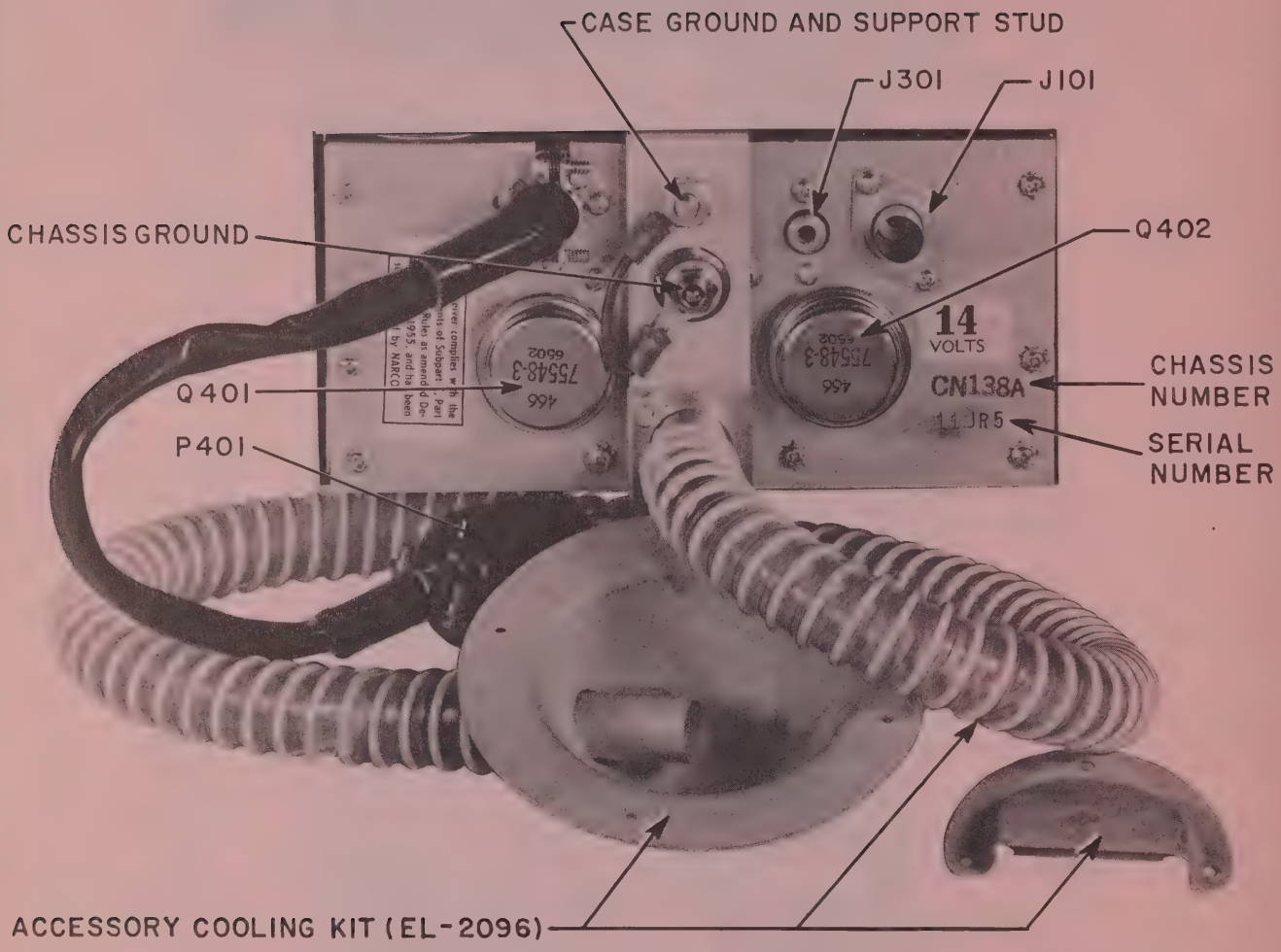
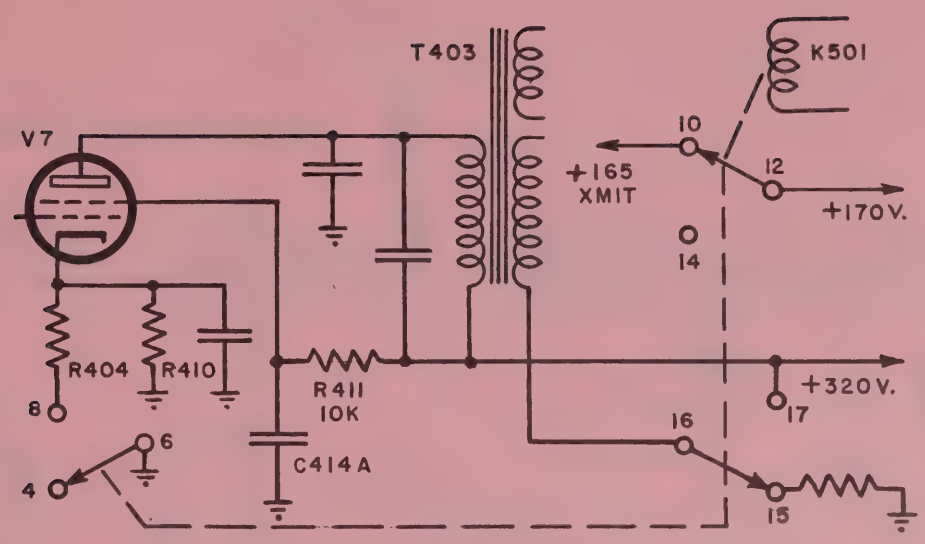


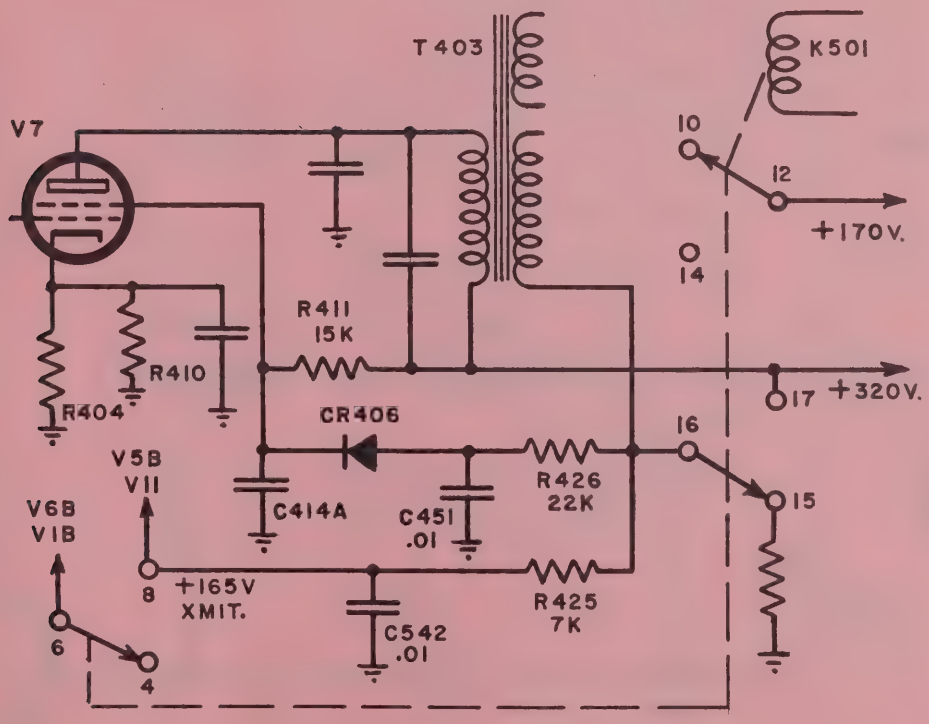
Photo Ha.
REAR VIEW, with CASE and COOLING KIT.
narco Mark-III Equipment

Reference page 39, in original manual and page 68 in Supplement 1

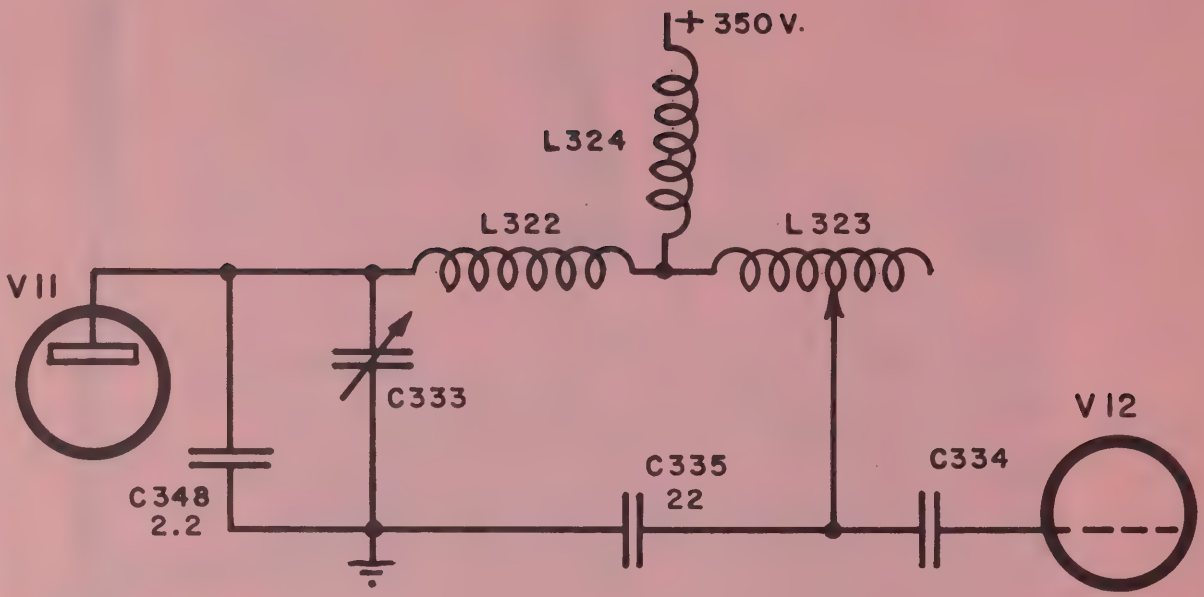


CHASSIS No. CN138 B5 AND BELOW

CHASSIS No. CN138 B6

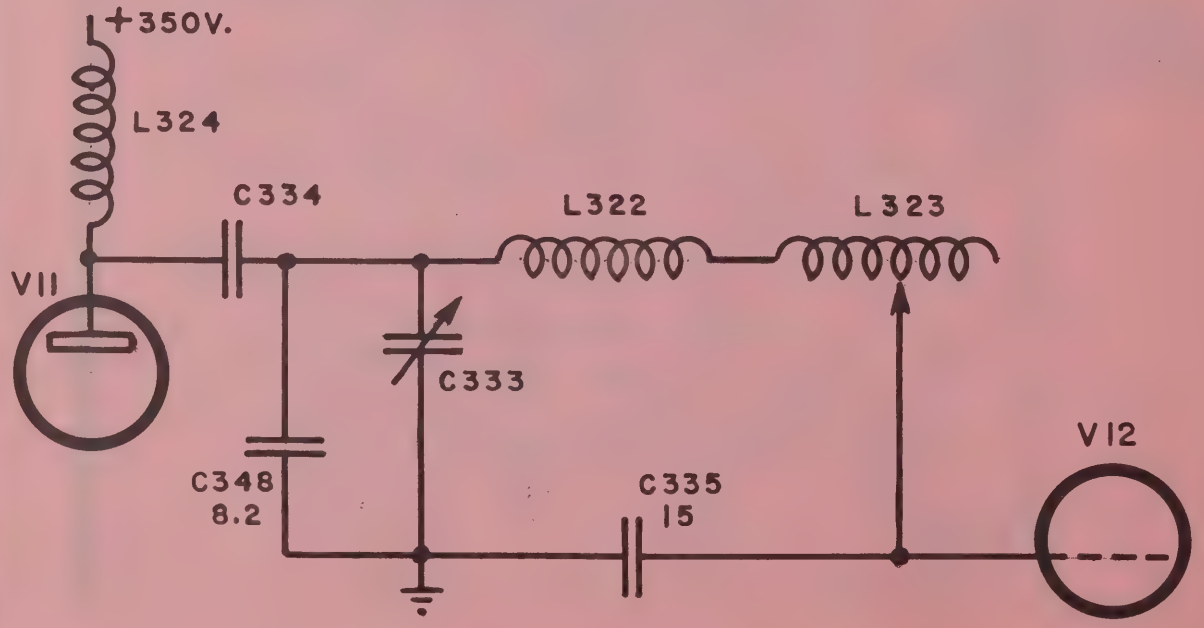


M-07248
Figure 9. Transmit/Receive Relay (V-501) Interconnections



CHASSIS No. CN138 B5 AND BELOW

CHASSIS No. CN138 B6

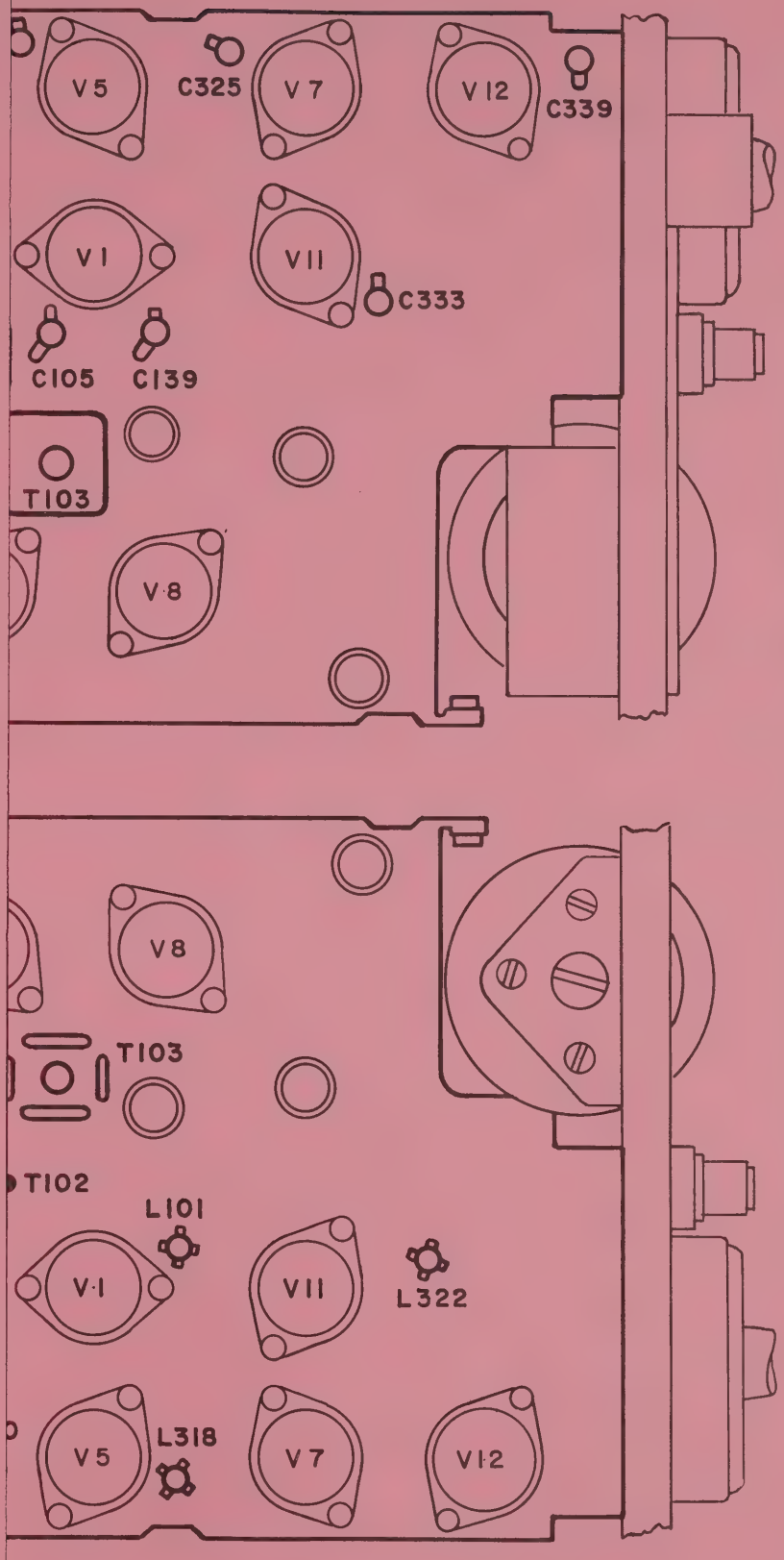


M-07249
Figure 10. Transmitter Interstage Coupling

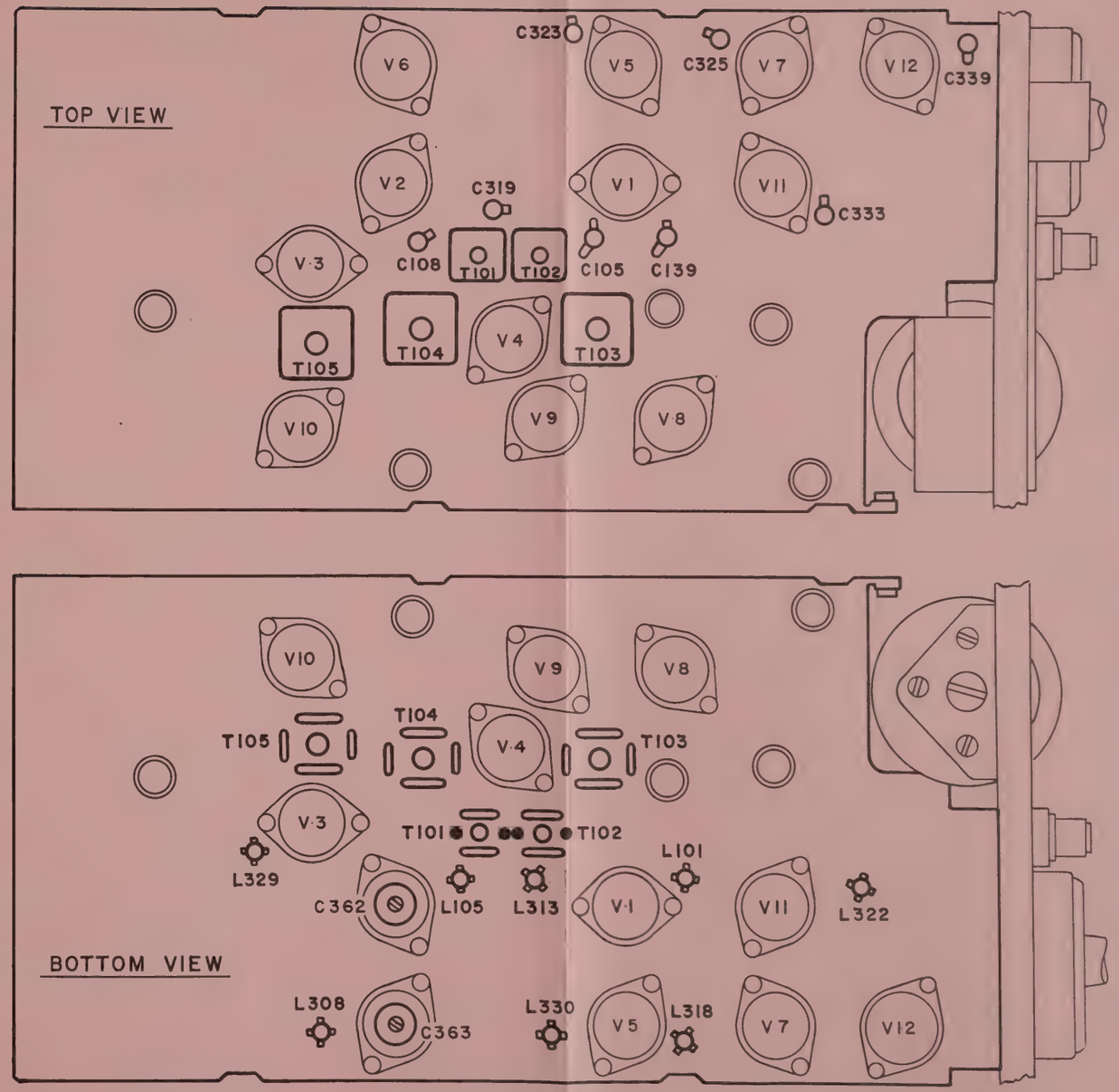
REPLACEMENT PARTS LIST.

The electrical components listed below are affected by the changes made in the chassis numbered CN 138-B6 and B7. The part numbers and item descriptions given below supersede the descriptions given in the original maintenance manual unless otherwise indicated. When ordering these parts from ***narco***, please list the chassis number and the source used to obtain this part number (supplements parts list).

SYMBOL	NARCO PART NO.	DESCRIPTION	STARTING WITH CHASSIS NUMBER:
		COMPONENTS CHANGED TO:	
C-335	21201-150	Capacitor, Cer. Tub., 15pf, 500V, ±10%	CN138-B6
C-348	21206-829	Capacitor, Cer. Tub., 8.2pf, 500V, ±.5pf, N470	CN138-B6
R-411	31135-153	Resistor, Carbon, 15K, ±10%, 1W	CN138-B6
		CHANGED FROM MYLAR TO POLYCARBONATE	
C-210	23092-125	Capacitor, Polycarbonate, 0.1μf, 75V, ±5%	CN138-B7
C-211	23092-125	Capacitor, Polycarbonate, 0.1μf, 75V, ±5%	CN138-B7
C-231	23092-63	Capacitor, Polycarbonate, 0.01μf, 75V, 10%	CN138-B7
C-232	23092-63	Capacitor, Polycarbonate, 0.01μf, 75V, 10%	CN138-B7
		CHANGED FROM MYLAR TO DIPPED MICA	
C-220	24045-472	Capacitor, Dipped Mica, 4700pf, 300V, ±5%	CN138-B7
C-221	24045-472	Capacitor, Dipped Mica, 4700pf, 300V, ±5%	CN138-B7
		CAPACITORS BELOW CHANGED IN CHASSIS NO. CN138-B7 ONLY (connected across T-103, T-104, T-105)	
C-118	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-125	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-126	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-131	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B7
C-135	21205-220	Capacitor, Cer. Tub., 22pf, 500 V, ±10%, N330	CN138-B6
		COMPONENTS ADDED	
C-451	21291-6	Capacitor, Cer. Disc, 0.1μf, 500 V GMV	CN138-B6
C-452	21291-6	Capacitor, Cer. Disc, 0.1μf, 500 V GMV	CN138-B6
R-425	31175-12	Resistor, Wirewound, 7K, ±10%, 5W	CN138-B6
R-426	31135-223	Resistor, Carbon, 22K, ±10%, 1W	CN138-B6
		ERROR ON SCHEMATIC, C-401 IS NOW:	
C-403	23085-271	Capacitor, Mylar, 0.047Ωf, 400V, ±10%	CN138-B6
		ADDITIONAL LISTING	
None	88156-101	Dial, Channel Selector, Tenths Mc/s	
None	04300	Dial, Decal, Tenths Mc/s channels	
None	88157-101	Dial, Channel Selector, Whole Mc/s	
None	04301	Dial, Decal, Whole Mc/s Channels	

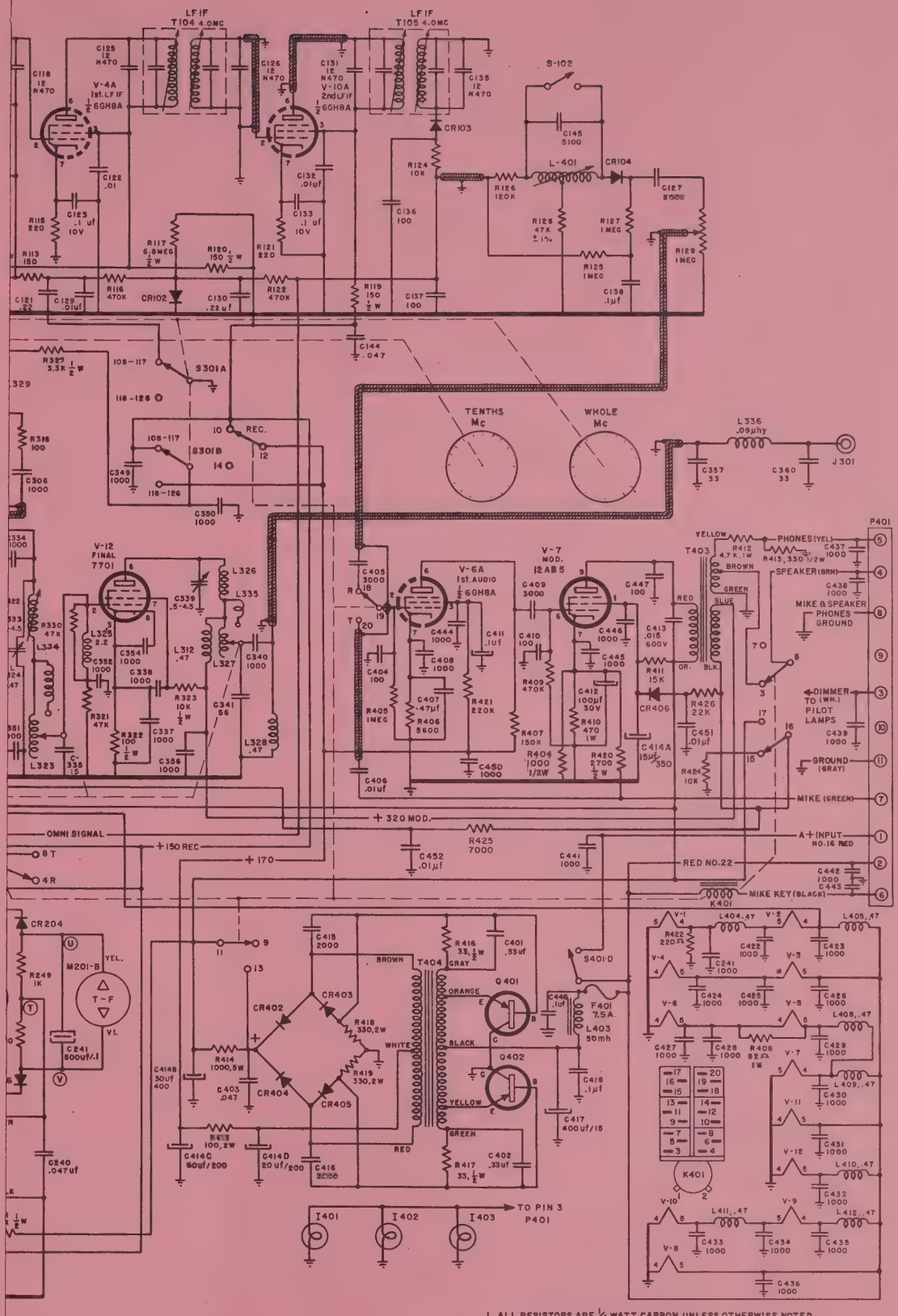


ols, Top and Underside of Chassis



P-07252

Figure 11. Location of Alignment Controls, Top and Underside of Chassis



1. ALL RESISTORS ARE ¼ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.

Figure 7b
SCHEMATIC, *narco* Mark III
for CN138-B7
PRODUCTION CHANGES
LOCATED ON APRON OF PAGE.

Since the manufacture of the original Mark-3 Omnigator, there have been various electrical and mechanical changes made to suit the customers requirements. Each electrical and/or mechanical change has been identified by assigning a new chassis number. Starting with the original manufactured Mark III, the chassis numbers range between CN 138-A1 and CN 138-B6. The original maintenance manual (3076-600) includes a schematic of the CN 138-A7 chassis, Supplement 1 includes a schematic of the CN 138-B5 chassis, and this Supplement includes a schematic of the CN 138-B7 chassis. A large percentage of the components are not affected by the chassis changes and the schematic can be used in these areas: if the chassis number does not agree with the schematic, use this list of chassis changes. The list given below can be used as a guide to interpolate the changes in components to arrive at the correct schematic.

CN 138-B6

The following changes were made to improve the transmitter performance under high ambient temperature and low line voltage operating conditions: V-11 plate circuit rewired for minimum detuning due to heat; CR-406, C-451 & C-452, R-425 & R-426 added, and R-411 value changed; from .01/500 to .047/400 to suppress power supply switching transients.

CN 138-B7

Components changed to improve temperature stability: OMNI C-210, C-211, C-231, and C-232 changed to polycarbonate; LOCALIZER—C-220 and 221 (V-8B plate circuit) changed to 24045-472 ±5%; and RECEIVER — C-118, C-125, C-126, C-131, and C-135 (connected across primaries of T-103, T-104, and T-105) changed from 21206-120 N470 to 21205-220 N330.

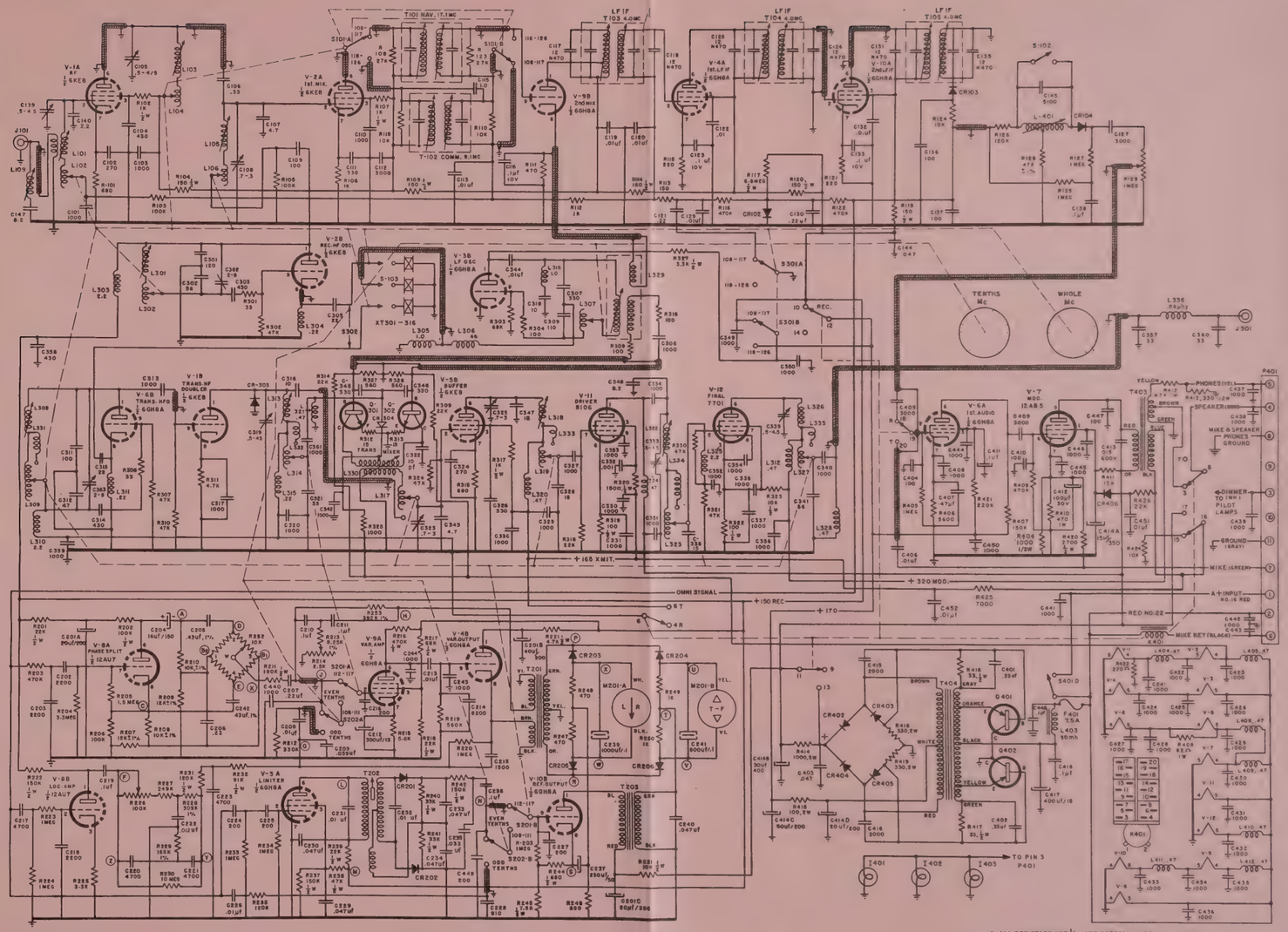

TENTHS Mc
WHOLE Mc
+165 XMIT.
+320 MOD.
+150 REC
+170
OMNI SIGNAL
1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS(pf)
3. ALL INDUCTANCES ARE MICRO-HENRIES(uh)
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.

Figure 7b
SCHEMATIC, ***narco*** Mark III
for CN138-B7
PRODUCTION CHANGES
LOCATED ON APRON OF PAGE.

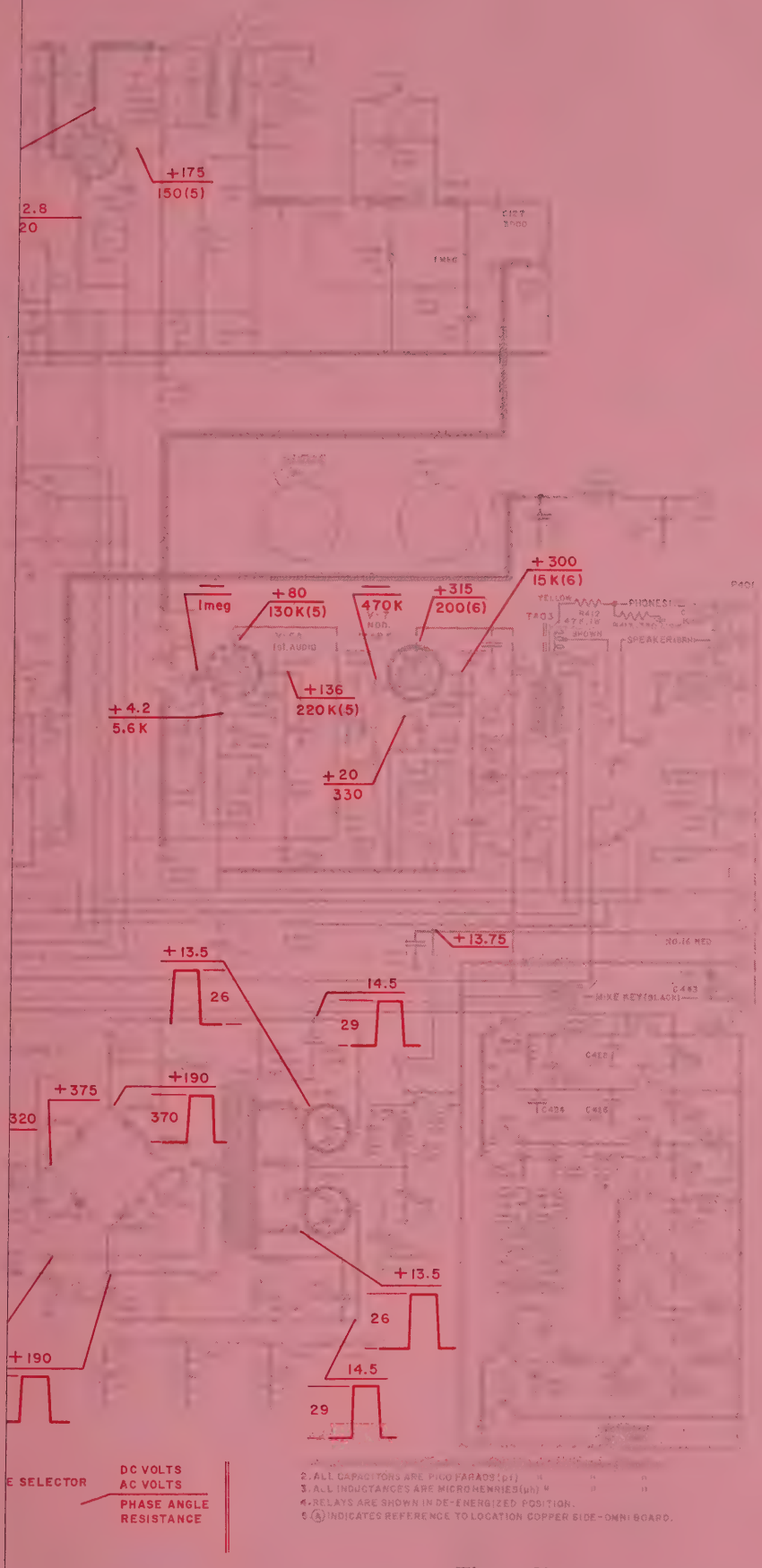


Figure 8b
SCHEMATIC with TEST DATA Overprint
narco Mark III
for CN138-B7

NOTES

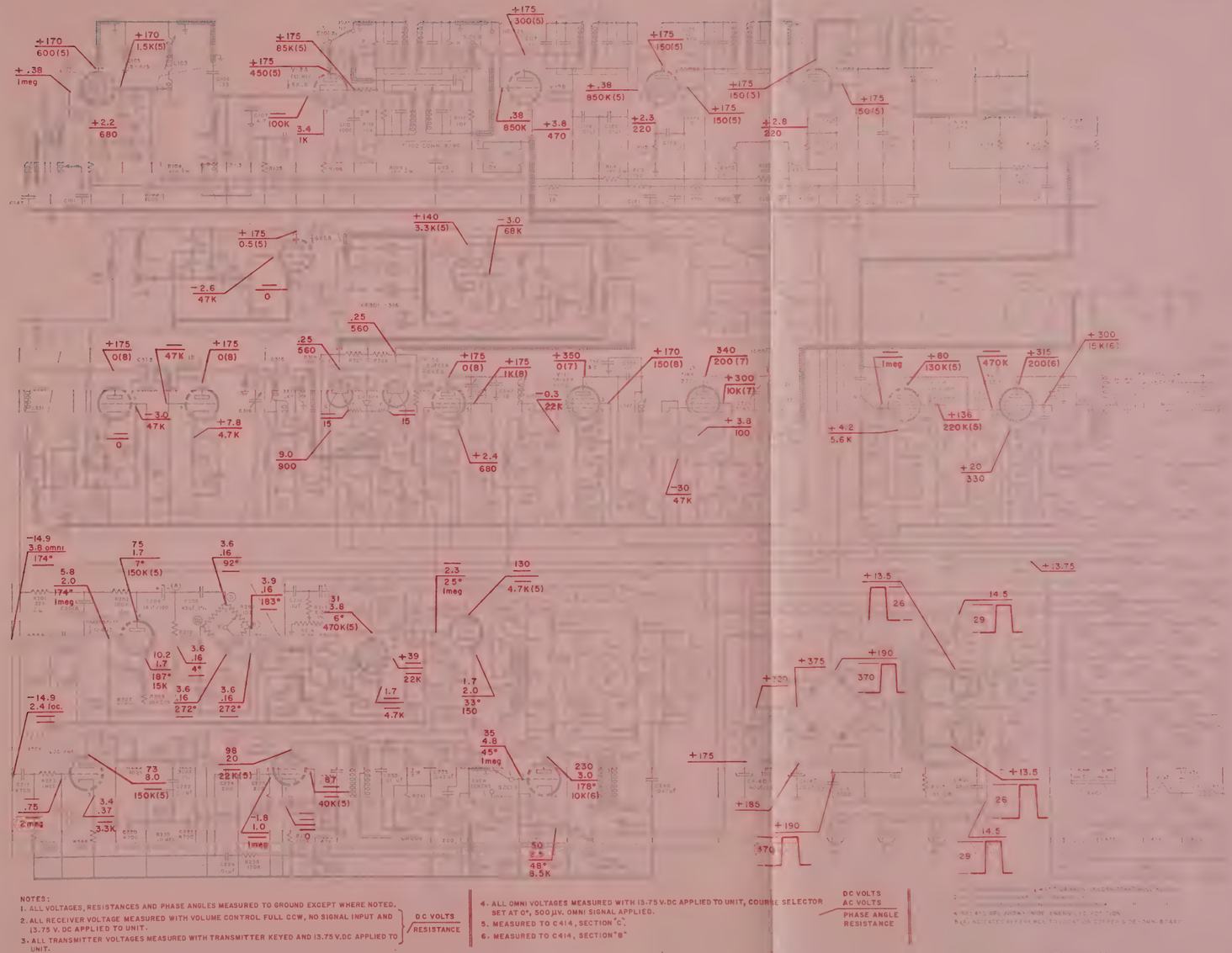

NOTES:
1. ALL VOLTAGES, RESISTANCES AND PHASE ANGLES MEASURED TO GROUND EXCEPT WHERE NOTED.
2. ALL RECEIVER VOLTAGE MEASURED WITH VOLUME CONTROL FULL CCW, NO SIGNAL INPUT AND 13.75 V. DC APPLIED TO UNIT.
3. ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V.DC APPLIED TO UNIT.
DC VOLTS
RESISTANCE
4. ALL OMNI VOLTAGES MEASURED WITH 13.75 V.DC APPLIED TO UNIT, COURSE SELECTOR SET AT 0°, 500 μV. OMNI SIGNAL APPLIED.
5. MEASURED TO C414, SECTION "C".
6. MEASURED TO C414, SECTION "B"
DC VOLTS
AC VOLTS
PHASE ANGLE
RESISTANCE

Figure 8b
SCHEMATIC with TEST DATA Overprint
narco Mark III
for CN138-B7

NARCO AVIONICS

Supplement 3
Place this sheet at the front of the original manual 3076-600 to indicate that Supplement 3 is included in this Maintenance Manual.

MARK III

OMNIGATOR

MAINTENANCE MANUAL

for

CN-138-B8 thru CN-138-D5

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

3076-600
— 100 —

Printed in U.S.A.

February, 1968

MARK III

OMNIGATOR

MAINTENANCE MANUAL

for

CN-138-B8 thru CN-138-D5

Remove the front cover sheet and place it at the front of the Mark 3 Maintenance Manual to indicate that the manual has been updated to include all chassis changes up to CN-138-D5.

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NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

INTRODUCTION

This supplement documents the changes in Chassis Numbers CN-138-B8 thru CN-138-D5 of the Mark 3 Omnigator.

The Replacement Parts List in this supplement provides identification of those parts deleted, added, or changed. The Chassis Numbers shown, indicates when this action took place. When ordering other components, refer to the Supplements 1 and 2 or Section 7 of the original manual.

Upon inserting Figures 9 thru 15, the manual will contain a schematic for CN-138-A, -B5, -B7, -B8, -C, -C1, -C2, -D, -D1, -D3, -D4, and -D5.

GENERAL CORRECTIVE ACTION

Please correct:

(1) Maintenance Manual, Page 7, paragraph 1B; and in the Installation Manual, Page 1, under Specifications the following:

RECEIVER:
Sensitivity;
1.5 NAV, 2.5 COMM microvolt for 6 db signal + noise, to noise ratio.
Selectivity; IF
6 db (noise), 38 Kc minimum bandwidth.
60 db (skirt), 220 Kc maximum bandwidth.
Image Rejection:
NAV= 60 -55db COMM= 60 -45db
AVC;
4 db from 10 to 10,000 microvolts.
Audio Output;
1.5 watts.
Omni Accuracy;
± 4° maximum.
TRANSMITTER:
Modulation;
Minimum 70%, before clipping 85%
Duty Cycle;
Maximum 20%.
Power Output;
2 to 3 watts.

(2) Maintenance Manual, Page 10, paragraph 2-G, 1; and in the Installation Manual, Page 3, change to read:

Antenna coupling, NARCO Type VRP-40 or VRP-40A are available for dual receiver installations. A small loss in receiver sensitivity may be experienced, when two receivers are operated from the same antenna.

(3) Maintenance Manual, Page 27, TABLE A; and in the Installation Manual, Page 4, TABLE A, change the following to read:

9	WHITE/BROWN* in cable	L/R Info
10	WHITE/BLACK* in cable	from omni circuit

*These wires will be found in Chassis Nos. CN-138-C and above.

PRODUCT MODIFICATION SUMMARY

CN-138-B8, Figure 9 of Supplement 3

Capacitors in various stages of receiver and transmitter circuits changed from tubular type to disc, as follows:

C-107	24516-829	CAPACITOR, CERAMIC DISC, 8.2μμf ±0.5 μμf, 500V, NPO
C-140	24516-229	CAPACITOR, CERAMIC DISC, 2.2μμf ±0.25μμf, 500V, NPO
C-316	24516-100	CAPACITOR, CERAMIC, DISC, 10μμf ±1.0μμf, 500V, NPO
C-321	21201-330	CAPACITOR, CERAMIC DISC, 33pf ±10%, 500V
*C-322	24516-689	CAPACITOR, CERAMIC DISC, 6.8μμf ±0.5 μμf, 500V, NPO
C-328	24516-150	CAPACITOR, CERAMIC DISC, 15μμf ±10%, 500V, NPO
C-335	24516-150	CAPACITOR, CERAMIC DISC, 15μμf ±10%, 500V, NPO
C-343	24516-479	CAPACITOR, CERAMIC DISC, 4.7μμf ±0.5μμf, 500V, NPO
C-347	24516-180	CAPACITOR, CERAMIC DISC, 18μμf ±10%, 500V, NPO
L-332	11692-1	COIL, RF, Transmitter
L-333	11692-1	COIL, RF, Transmitter

*Value was also changed from 10 pf to 6.8μμf

CN-138-C, Figure 9 of Supplement 3.

Autopilot wires placed in the pigtail output from the meter circuit.

P-401-9 to M-201-A, WH
P-401-10 to M-201-A, BLK

CN-138-C1, Figure 10 of Supplement 3.

In transmitter, RF final amplifier V-12 (7701) . . . value of screen resistor R-323 increased from 10K to 27K to improve modulation characteristics of final amplifier. R-404 deleted, R-410 changed to 330 ohms. R-128 value changed to improve identification filter operation.

R-128	31195-473	RESISTOR, CARBON, 47K ohm ±1%, 1/4W
R-323	31141-273	RESISTOR, CARBON, 27K ohm ±10%, 1/2W
R-404	Deleted	
R-410	31135-331	RESISTOR, CARBON, 330 ohm ±10%, 1W

CN-138-C2, Figure 11 of Supplement 3.

LFO circuit V-3B: Oscillator feedback resistor (R-304) increased from 100 ohms to 560 ohms. Decrease oscillator injection level, reduction of 5 HFO harmonic content. Removed LFO trap, L-316 and C-318.
LOC operation: Phase shift in feedback circuit (R-220 an C-215) increased to provide more positive flag and needle deflection at low signal levels.

C-113	23085-63	CAPACITOR, MYLAR, .01pf ±10%, 100V
C-120	23085-63	CAPACITOR, MYLAR, .01pf ±10%, 100V
C-129	23085-63	CAPACITOR, MYLAR, .01pf ±10%, 100V
C-215	24045-911	CAPACITOR, DIPPED MICA, 910pf, ±5%, 500V
C-318	Deleted	
C-403	23094-271	CAPACITOR, METALIZED MYLAR, .047pf ±10%, 400V
L-316	Deleted	
L-401	11446-3	INDUCTOR, ADJUSTABLE
R-220	31192-684	RESISTOR, CARBON, 680K ohm ±10%, 1/4W
R-304	31192-561	RESISTOR, CARBON, 560 ohm ±10%, 1/2W

CN-138-D, No schematic change.

Transmitter mixer transistor (Q-301 and Q-302) replaced.

Q-301	75568-1	TRANSISTOR
Q-302	75568-1	TRANSISTOR

PRODUCT MODIFICATION SUMMARY (Continued)

CN-138-D1, Figure 12 of Supplement 3.

Transmitter buffer V-11: Plate feed was on constant plus 320V. Now moved to transmit plus 320. This will lengthen tube life and give better drive to final amplifier.

R-251 and R-424 type substitution.

R-251	31135-103	RESISTOR, CARBON, 10K ohm ±10%, 1W
R-424	31141-103	RESISTOR, CARBON, 10K ohm ±10%, 1/2W

CN-138-D2, Mechanical change to star wheel on Kc detent.

Star wheel staking to bushing redesigned to prevent detent roller wheel from jumping off.

CN-138-D3, Figure 13 of Supplement 3. (SUPERCEDED: SEE CN-138-D5).

LFO circuit: A 15 pf disc capacitor (C-365) was added across L-301 to aid in minimizing 5 LFO energy from beating with receiver or transmit HFO thus causing "birdies".

C-365	24516-150	CAPACITOR, CERAMIC DISC, 15$\mu\mu$f ±10%, 500V, NPO

CN-138-D4, Figure 14 of Supplement 3.

Localizer centering: To eleminate the need for localizer centering compensation and to increase L-R color at either limit of potentiometer (R-226), resistor (R-220) value changed to 1.5 mego and the compensation resistor across R-229 was removed. This change is applicable only to Chassis C-2 to D-3.

R-220	31192-155	RESISTOR, CARBON, 1.5 megohm ±10%, 1/4W

CN-138-D5, Figure 15 of Supplement 3.

"THIS CHANGE SUPERSEDES THE ABOVE CN-138-D3 CHANGE."

To provide a more acceptable way to minimize 5 LFO frequency change value of L-306 to 2.2uh.

This change requires the removal of capacitor C-365 which was added across L-301 on chassic CN-138-D3, plus the change of L-306 noted above.

C-365	Deleted	
L-306	11138-9	RF Choke 2.2uh

REPLACEMENT PARTS LIST

The below list of parts supplements the Replacement Parts Lists of the original manual and Supplements 1 and 2. It provides the support information resulting from changes incorporated herein. When ordering parts from NARCO AVIONICS, please list the chassis number and the source used to obtain the part number.

MISCELLANEOUS MECHANICAL PARTS

Part No.	Description	Reference
01381-0530	Omni board	(see Photo F & G)
01381-0510	Plate	(see Photo B)
42060-4	Socket, Tube, V-7	(see Photo C)
01381-0302	Front panel with labels	(see cover)
01381-512	Shaft, Mc	(see Photo B)
51633-1	Mark 3 bushing for case locking	(see Photo A)
81656-11	Front panel plug button for unit to case latch assy	(see Photo A)
04065	Label, front panel "Transmits 122.1 when set to NAV Channels"	(see cover)
04349-1	Label, front panel "Mark 3"	
04342-1	Logo—NARCO	
04352-1	Label, Color (red)	
04352-2	Label, Color (white)	
81747-3	Filter, bulb (white)	
81747-5	Filter, bulb (red)	

ELECTRICAL PARTS

Symbol	Narco Part No.	Description	Starting with Chassis Number
C-107 (Type Substitution)	24516-829	CAPACITOR, CERAMIC DISC, 8.2 $\mu\mu$f $\pm$0.5$\mu\mu$f, 500V, NPO	CN-138-B8
C-113 (Type Substitution)	23085-63	CAPACITOR, MYLAR, .01pf $\pm$10%, 100V	CN-138-C2
C-120 (Type Substitution)	23085-63	CAPACITOR, MYLAR, .01pf $\pm$10%, 100V	CN-138-C2
C-129 (Type Substitution)	23085-63	CAPACITOR, MYLAR, .01pf $\pm$10%, 100V	CN-138-C2
C-140 (Type Substitution)	24516-229	CAPACITOR, CERAMIC, DISC, 2.2$\mu\mu$f $\pm$0.25$\mu\mu$f, 500V, NPO	CN-138-B8
C-215 (Changed)	24045-911	CAPACTOR, DIPPED MICA, 910pf $\pm$5%, 500V	CN-138-C2
C-316 (Type Substitution)	24516-100	CAPACITOR, CERAMIC DISC, 10$\mu\mu$f $\pm$1.0$\mu\mu$f, 500V, NPO	CN-138-B8
C-318 (Deleted)			CN-138-C2
C-321 (Type Substitution)	21201-330	CAPACITOR, CERAMIC DISC, 33pf $\pm$10%, 500V	CN-138-B8
C-322 (Changed)	24516-689	CAPACITOR, CERAMIC DISC, 6.8$\mu\mu$f $\pm$0.5$\mu\mu$f, 500V, NPO	CN-138-B8
C-328 (Type Substitution)	24516-150	CAPACITOR, CERAMIC DISC, 15$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-B8
C-335 (Type Substitution)	24516-150	CAPACITOR, CERAMIC DISC, 15$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-B8
C-343 (Type Substitution)	24516-479	CAPACITOR, CERAMIC DISC, 4.7$\mu\mu$f $\pm$0.5$\mu\mu$f, 500V, NPO	CN-138-B8
C-347 (Type Substitution)	24516-180	CAPACITOR, CERAMIC DISC, 18$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-B8
C-365 (Added)	24516-150	CAPACITOR, CERAMIC DISC, 15$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-D3
C-365 (Deleted)			CN-138-D5
C-403 (Type Substitution)	23094-271	CAPACITOR, METALIZED MYLAR, .047pf $\pm$10%, 400V	CN-138-C2
L-306 (Type Substitution)	11138-9	CHOKE, R.F. 2.2μh	CN-138-D5
L-316 (Deleted)			CN-138-C2
L-332 (Type Substitution)	11692-1	COIL, R.F., Transmitter	CN-138-B8
L-333 (Type Substitution)	11692-1	COIL, R.F., Transmitter	CN-138-B8
L-401 (Type Substitution)	11446-3	INDUCTOR, ADJUSTABLE	CN-138-C2
Q-301 (Type Substitution)	75568-1	TRANSISTOR	CN-138-D
Q-302 (Type Substitution)	75568-1	TRANSISTOR	CN-138-D
R-128 (Changed)	31195-473	RESISTOR, CARBON, 47K ohm $\pm$1%, 1/4W	CN-138-C1
R-220 (Changed)	31192-684	RESISTOR, CARBON, 680K ohm $\pm$10%, 1/4W	CN-138-C2
R-220 (Changed)	31192-155	RESISTOR, CARBON, 1.5 megohm $\pm$10%, 1/4W	CN-138-D4
R-251 (Type Substitution)	31135-103	RESISTOR, CARBON, 10K ohm $\pm$10%, 1W	CN-138-D1
R-304 (Changed)	31192-561	RESISTOR, CARBON, 560 ohm $\pm$10%, 1/4W	CN-138-C2
R-304 (Changed)	31192-101	RESISTOR, CARBON, 100 ohm $\pm$10%, 1/4W	CN-138-D5
R-323 (Changed)	31141-273	RESISTOR, CARBON, 27K ohm $\pm$10%, 1/2W	CN-138-C1
R-404 (Deleted)			CN-138-C1
R-410 (Changed)	31135-331	RESISTOR, CARBON, 330 ohm $\pm$10%, 1W	CN-138-C1
R-424 (Type Substitution)	31141-103	RESISTOR, CARBON, 10K ohm $\pm$10%, 1/2W	CN-138-D1

LOW VOLTAGE RECEIVER FAILURE

Aircraft equipped with generators (NOT alternators) have reported receiver failure. This failure was traced to the two 6KE8 tubes used in the receiver HFO. A kit (EL-3076-505) is available to eliminate this problem.

The modification is performed as follows:

1. Remove R-422, a 220 ohm resistor connected from pin #4 of V-1 to ground.
2. Replace V-1 and V-2 with 5KE8 tubes.
3. Attach modification label:

   "Note: V-1 and V-2 have been changed to type 5KE8 tubes to aid Low Voltage operation in generator equipped aircraft."

REPLACEMENT PARTS LIST

The below list of parts supplements the Replacement Parts Lists of the original manual and Supplements 1 and 2. It provides the support information resulting from changes incorporated herein. When ordering parts from NARCO AVIONICS, please list the chassis number and the source used to obtain the part number.

MISCELLANEOUS MECHANICAL PARTS

Part No.	Description	Reference
01381-0530	Omni board	(see Photo F & G)
01381-0510	Plate	(see Photo B)
42060-4	Socket, Tube, V-7	(see Photo C)
01381-0302	Front panel with labels	(see cover)
01381-512	Shaft, Mc	(see Photo B)
51633-1	Mark 3 bushing for case locking	(see Photo A)
81656-11	Front panel plug button for unit to case latch assy	(see Photo A)
04065	Label, front panel "Transmits 122.1 when set to NAV Channels"	(see cover)
04349-1	Label, front panel "Mark 3"	
04342-1	Logo—NARCO	
04352-1	Label, Color (red)	
04352-2	Label, Color (white)	
81747-3	Filter, bulb (white)	
81747-5	Filter, bulb (red)	

ELECTRICAL PARTS

Symbol	Narco Part No.	Description	Starting with Chassis Number
C-107 (Type Substitution)	24516-829	CAPACITOR, CERAMIC DISC, 8.2 $\mu\mu$f $\pm$0.5$\mu\mu$f, 500V, NPO	CN-138-B8
C-113 (Type Substitution)	23085-63	CAPACITOR, MYLAR, .01pf $\pm$10%, 100V	CN-138-C2
C-120 (Type Substitution)	23085-63	CAPACITOR, MYLAR, .01pf $\pm$10%, 100V	CN-138-C2
C-129 (Type Substitution)	23085-63	CAPACITOR, MYLAR, .01pf $\pm$10%, 100V	CN-138-C2
C-140 (Type Substitution)	24516-229	CAPACITOR, CERAMIC, DISC, 2.2$\mu\mu$f $\pm$0.25$\mu\mu$f, 500V, NPO	CN-138-B8
C-215 (Changed)	24045-911	CAPACTOR, DIPPED MICA, 910pf $\pm$5%, 500V	CN-138-C2
C-316 (Type Substitution)	24516-100	CAPACITOR, CERAMIC DISC, 10$\mu\mu$f $\pm$1.0$\mu\mu$f, 500V, NPO	CN-138-B8
C-318 (Deleted)			CN-138-C2
C-321 (Type Substitution)	21201-330	CAPACITOR, CERAMIC DISC, 33pf $\pm$10%, 500V	CN-138-B8
C-322 (Changed)	24516-689	CAPACITOR, CERAMIC DISC, 6.8$\mu\mu$f $\pm$0.5$\mu\mu$f, 500V, NPO	CN-138-B8
C-328 (Type Substitution)	24516-150	CAPACITOR, CERAMIC DISC, 15$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-B8
C-335 (Type Substitution)	24516-150	CAPACITOR, CERAMIC DISC, 15$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-B8
C-343 (Type Substitution)	24516-479	CAPACITOR, CERAMIC DISC, 4.7$\mu\mu$f $\pm$0.5$\mu\mu$f, 500V, NPO	CN-138-B8
C-347 (Type Substitution)	24516-180	CAPACITOR, CERAMIC DISC, 18$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-B8
C-365 (Added)	24516-150	CAPACITOR, CERAMIC DISC, 15$\mu\mu$f $\pm$10%, 500V, NPO	CN-138-D3
C-365 (Deleted)			CN-138-D5
C-403 (Type Substitution)	23094-271	CAPACITOR, METALIZED MYLAR, .047pf $\pm$10%, 400V	CN-138-C2
L-306 (Type Substitution)	11138-9	CHOKE, R.F. 2.2μh	CN-138-D5
L-316 (Deleted)			CN-138-C2
L-332 (Type Substitution)	11692-1	COIL, R.F., Transmitter	CN-138-B8
L-333 (Type Substitution)	11692-1	COIL, R.F., Transmitter	CN-138-B8
L-401 (Type Substitution)	11446-3	INDUCTOR, ADJUSTABLE	CN-138-C2
Q-301 (Type Substitution)	75568-1	TRANSISTOR	CN-138-D
Q-302 (Type Substitution)	75568-1	TRANSISTOR	CN-138-D
R-128 (Changed)	31195-473	RESISTOR, CARBON, 47K ohm $\pm$1%, 1/4W	CN-138-C1
R-220 (Changed)	31192-684	RESISTOR, CARBON, 680K ohm $\pm$10%, 1/4W	CN-138-C2
R-220 (Changed)	31192-155	RESISTOR, CARBON, 1.5 megohm $\pm$10%, 1/4W	CN-138-D4
R-251 (Type Substitution)	31135-103	RESISTOR, CARBON, 10K ohm $\pm$10%, 1W	CN-138-D1
R-304 (Changed)	31192-561	RESISTOR, CARBON, 560 ohm $\pm$10%, 1/4W	CN-138-C2
R-304 (Changed)	31192-101	RESISTOR, CARBON, 100 ohm $\pm$10%, 1/4W	CN-138-D5
R-323 (Changed)	31141-273	RESISTOR, CARBON, 27K ohm $\pm$10%, 1/2W	CN-138-C1
R-404 (Deleted)			CN-138-C1
R-410 (Changed)	31135-331	RESISTOR, CARBON, 330 ohm $\pm$10%, 1W	CN-138-C1
R-424 (Type Substitution)	31141-103	RESISTOR, CARBON, 10K ohm $\pm$10%, 1/2W	CN-138-D1

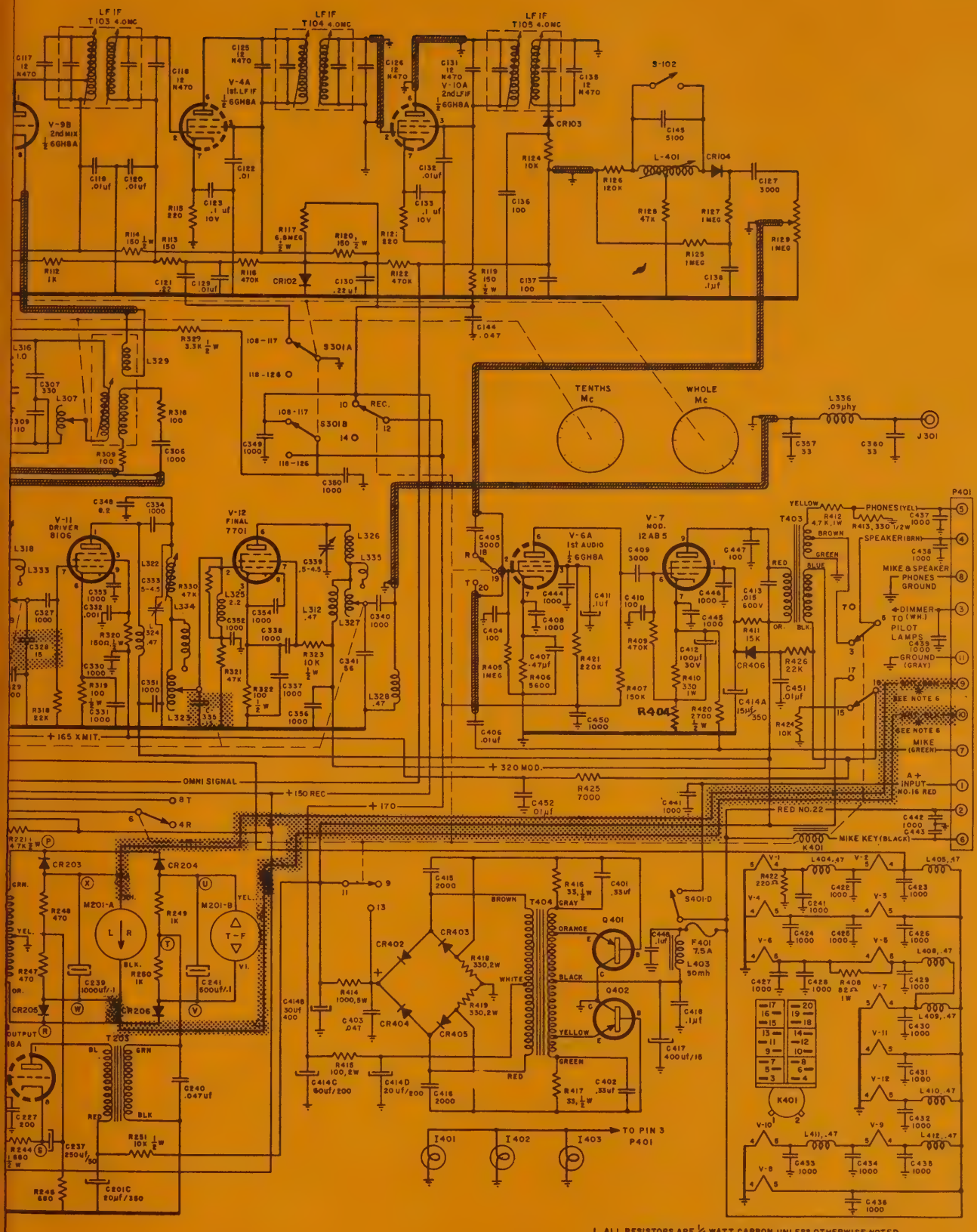
LOW VOLTAGE RECEIVER FAILURE

Aircraft equipped with generators (NOT alternators) have reported receiver failure. This failure was traced to the two 6KE8 tubes used in the receiver HFO. A kit (EL-3076-505) is available to eliminate this problem.

The modification is performed as follows:

1. Remove R-422, a 220 ohm resistor connected from pin #4 of V-1 to ground.
2. Replace V-1 and V-2 with 5KE8 tubes.
3. Attach modification label:

   "Note: V-1 and V-2 have been changed to type 5KE8 tubes to aid Low Voltage operation in generator equipped aircraft."



1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS No. CN138C & ABOVE.

FIGURE 9. MARK 3, SCHEMATIC FOR CN-138-B-8 AND -C

LOW VOLTAGE RECEIVER FAILURE

Aircraft equipped with generators (NOT alternators) have reported receiver failure. This failure was traced to the two 6KE8 tubes used in the receiver HFO. A kit (EL-3076-505) is available to eliminate this problem.

The modification is performed as follows:

1. Remove R-422, a 220 ohm resistor connected from pin #4 of V-1 to ground.
2. Replace V-1 and V-2 with 5KE8 tubes.
3. Attach modification label:

   "Note: V-1 and V-2 have been changed to type 5KE8 tubes to aid Low Voltage operation in generator equipped aircraft."

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-B8, Figure 9 of Supplement 3.

Capacitors in various stages of receiver and transmitter circuits changed from tubular type or disc, as follows:

C-107	24516-829	CAPACITOR, CERAMIC DISC, 8.2μμf ±0.5μμf, 500V, NPO
C-140	24516-229	CAPACITOR, CERAMIC DISC, 2.2μμf ±0.25μμf, 500V, NPO
C-316	24516-100	CAPACITOR, CERAMIC DISC, 10μμf ±1.0μμf, 500V, NPO
C-321	21201-330	CAPACITOR, CERAMIC DISC, 33pf ±10%, 500V
*C-322	24516-689	CAPACITOR, CERAMIC DISC, 6.8 μμf ±0.5μμf, 500V, NPO
C-328	24516-150	CAPACITOR, CERAMIC DISC, 15μμf, ±10%, 500V, NPO
C-335	24516-150	CAPACITOR, CERAMIC DISC, 15μμf, ±10%, 500V, NPO
C-343	24516-479	CAPACITOR, CERAMIC DISC, 4.7μμf ±0.5μμf 500V, NPO
C-347	24516-180	CAPACITOR, CERAMIC DISC, 18μμf ±10%, 500V, NPO
L-332	11692-1	COIL, RF, Transmitter
L-333	11692-1	COIL, RF, Transmitter

*Value was also changed from 10 pf to 6.8μμf

CN-138-C, Figure 9 of Supplement 3.

Autopilot wires placed in the pigtail output from the meter circuit.

P-401-9 to M-201-A, WH
P-401-10 to M-201-A, BLK

"See Figure 8b for test points and service plate" data.

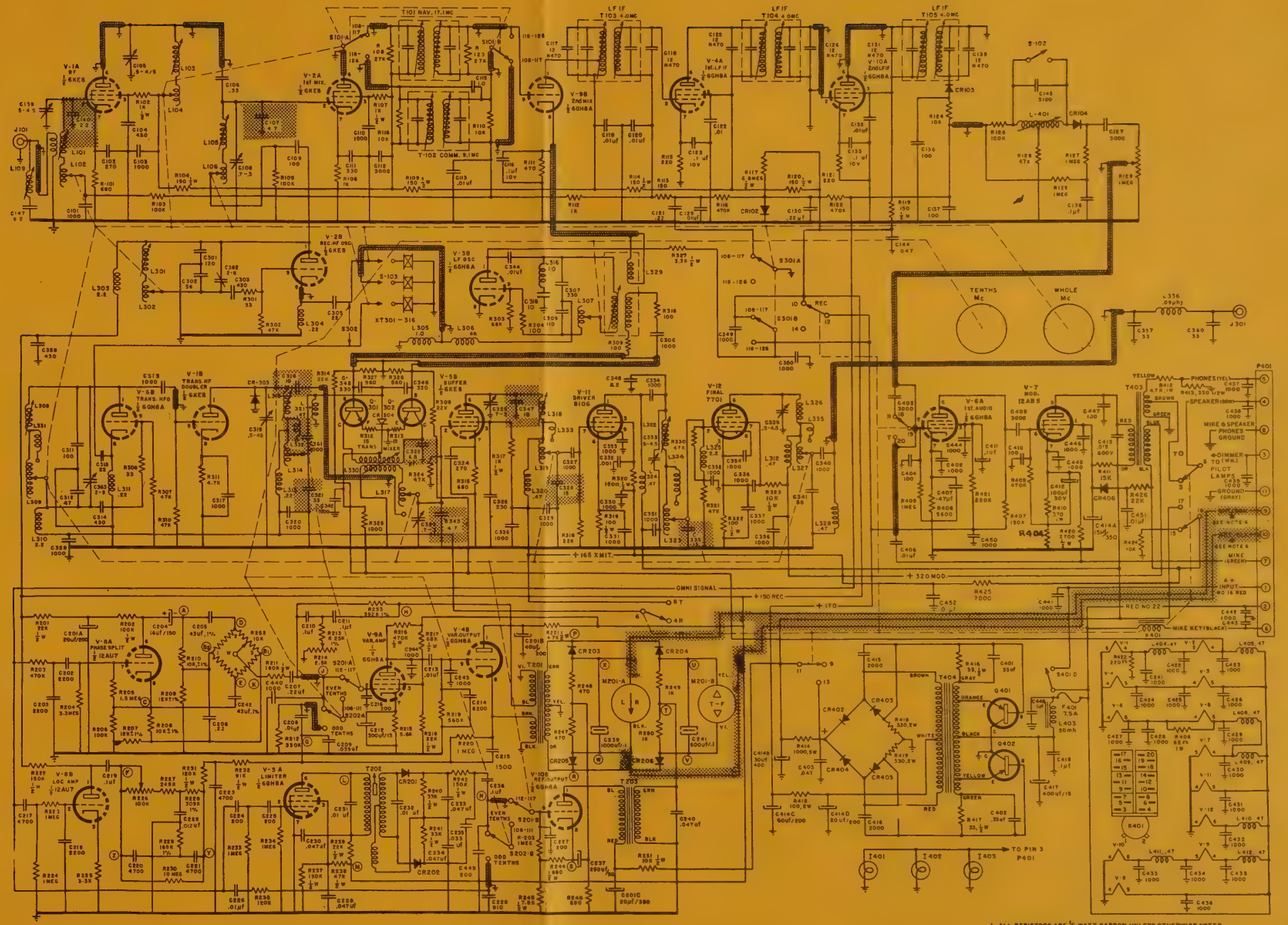
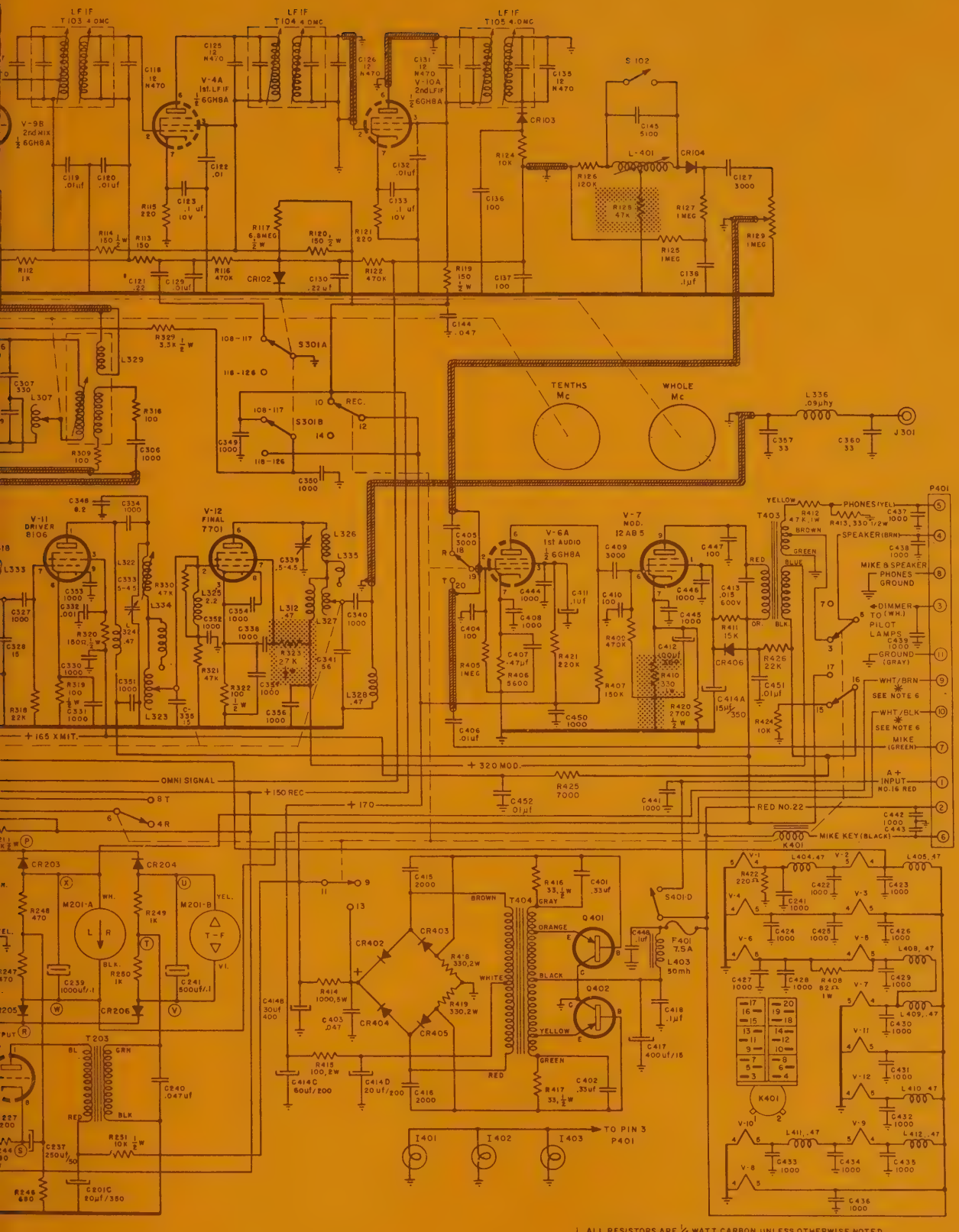


FIGURE 9. MARK 3, SCHEMATIC FOR CN-138-B-8 AND -C



1. ALL RESISTORS ARE ¼ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICROHENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS NO. CN138C & ABOVE

FIGURE 10. MARK 3, SCHEMATIC FOR CN-138-C-1

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-C1, Figure 10 of Supplement 3.

In transmitter, RF final amplifier V-12 (7701) . . . value of screen resistor R-323 increased from 10K to 27K to improve modulation characteristics of final amplifier. R-404 deleted, R-410 changed to 330 ohms. R-128 value changed to improve identification filter operation.

R-128	31195-473	RESISTOR, CARBON, 47K ohm ±1%, 1/4W
R-323	31141-273	RESISTOR, CARBON, 27K ohm ±10%, 1/2W
R-404	Deleted	
R-410	31135-331	RESISTOR, CARBON, 330 ohm ±10%, 1W

"See Figure 8b for test points and service data."

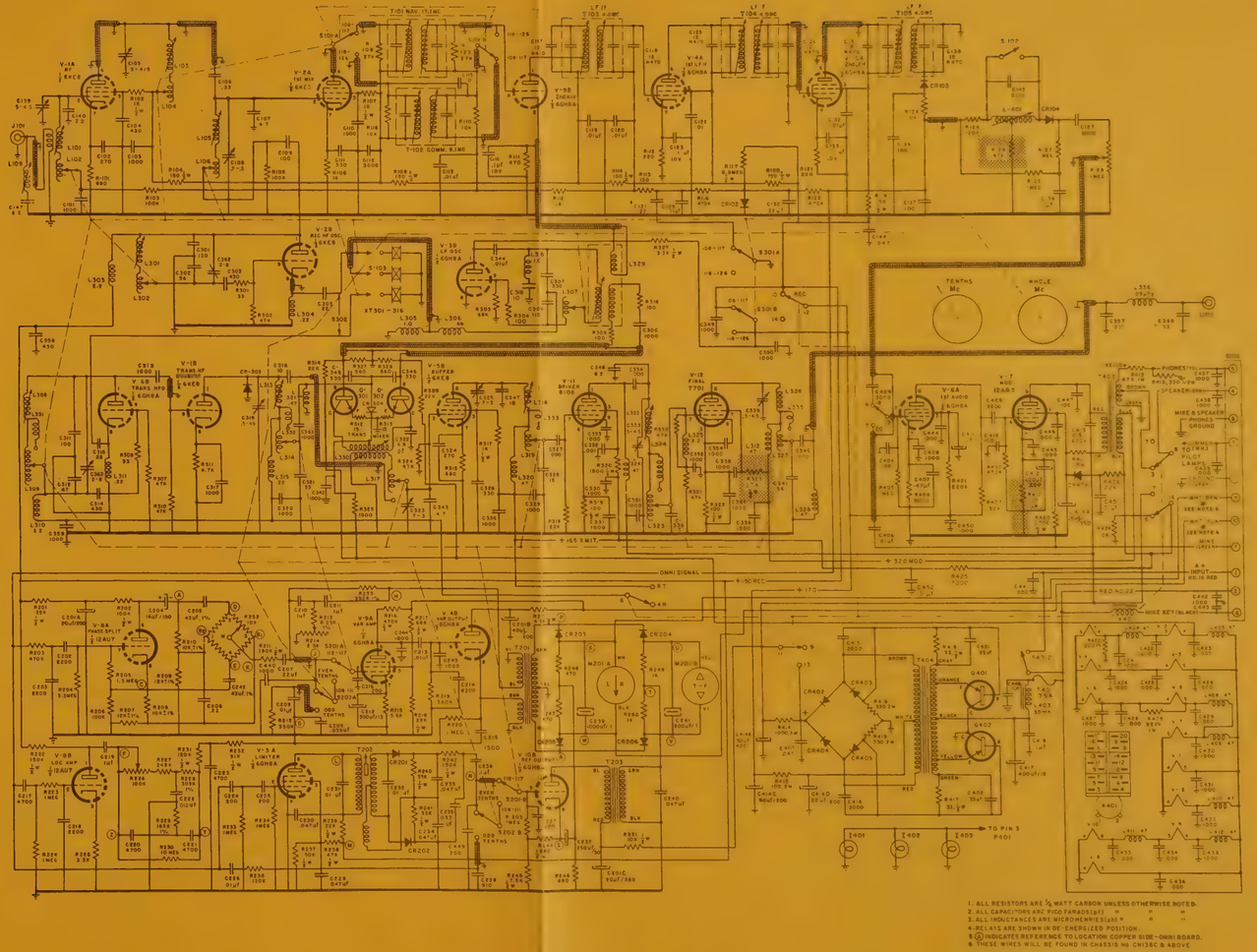
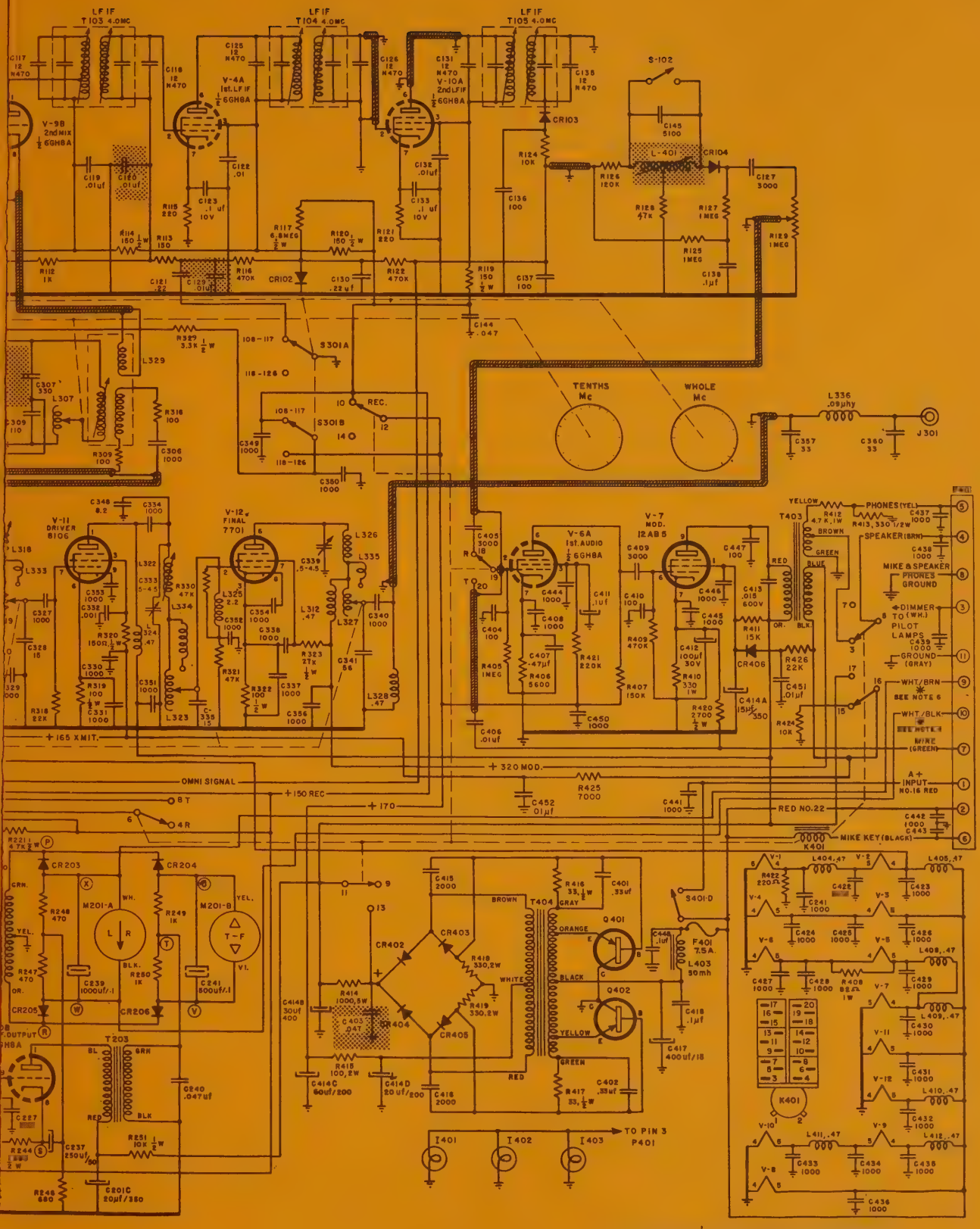

TENTHS Mc
WHOLE Mc
OMNI SIGNAL
TO PIN 3 P401
1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICOFARADS(pf) "
3. ALL INDUCTANCES ARE MICROHENRIES(uh) "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS No CN138C & ABOVE

FIGURE 10. MARK 3, SCHEMATIC FOR CN-138-C-1



1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS No. CN138C & ABOVE.

FIGURE 11, MARK 3, SCHEMATIC FOR CN-138-C-2

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-C2, Figure 11 of Supplement 3.

LFO circuit V-3B: Oscillator feedback resistor (R-304) increased from 100 ohms of 560 ohms. Decrease oscillator injection level, reduction of 5 HFO harmonic content. Remove LFO trap, L-316 and C-318.
LOC operation: Phase shift in feedback circuit (R-220 and C-215) increased to provide more positive flag and needle deflection at low signal levels.

C-113	23085-63	CAPACITOR, MYLAR, .01pf ±10%, 100V
C-120	23085-63	CAPACITOR, MYLAR, .01pf ±10%, 100V
C-129	23085-63	CAPACITOR, MYLAR, .01pf ±10%, 100V
C-215	24045-911	CAPACITOR, DIPPED MICA, 910pf, ±5%, 500V
C-318	Deleted	
C-403	23094-271	CAPACITOR, METALIZED MYLAR, .047pf ±10%, 400V
L-316	Deleted	
L-401	11446-3	INDUCTOR, ADJUSTABLE
R-220	31192-684	RESISTOR, CARBON, 680K ohm ±10%, 1/4W
R-304	31192-561	RESISTOR, CARBON, 27K ohm ±10%, 1/2W

"See Figure 8b for test points and service data."

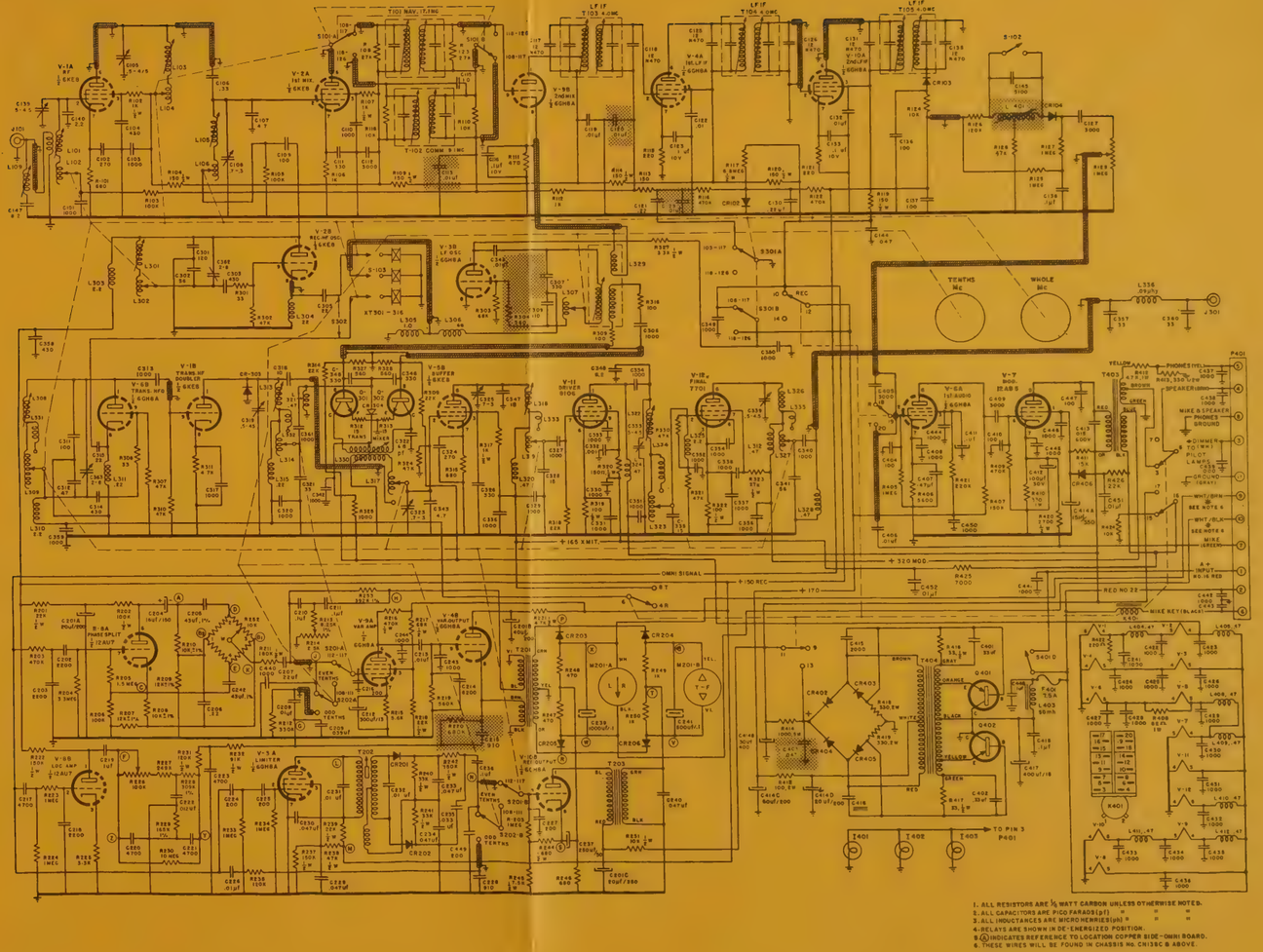
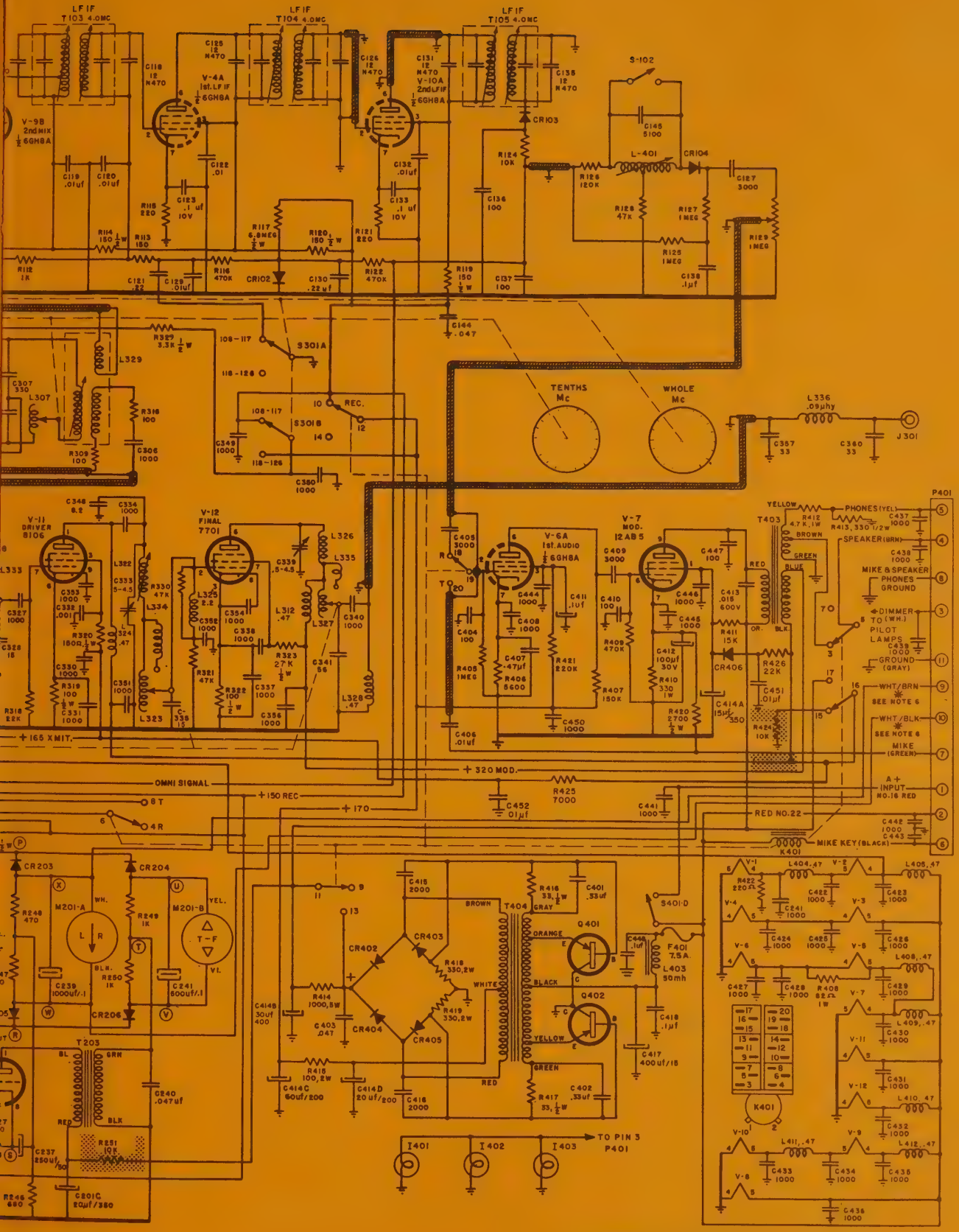


FIGURE 11, MARK 3, SCHEMATIC FOR CN-138-C-2



1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf)
3. ALL INDUCTANCES ARE MICRO HENRIES (μh)
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS No. CN138C & ABOVE.

FIGURE 12. MARK 3, SCHEMATIC FOR CN-138-D-1

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-D1, Figure 12 of Supplement 3.

Transmitter buffer V-11: Plate feed was on constant plus 320V. Now moved to transmit plus 320. This will lengthen tube life and give better drive to final amplifier.

R-251 and R-424 type substitution.

R-251	31135-103	RESISTOR, CARBON, 10K ohm ±10%, 1W
R-424	31141-103	RESISTOR, CARBON, 10K ohm ±10%, 1/2W

"See Figure 8b for test points and service data."

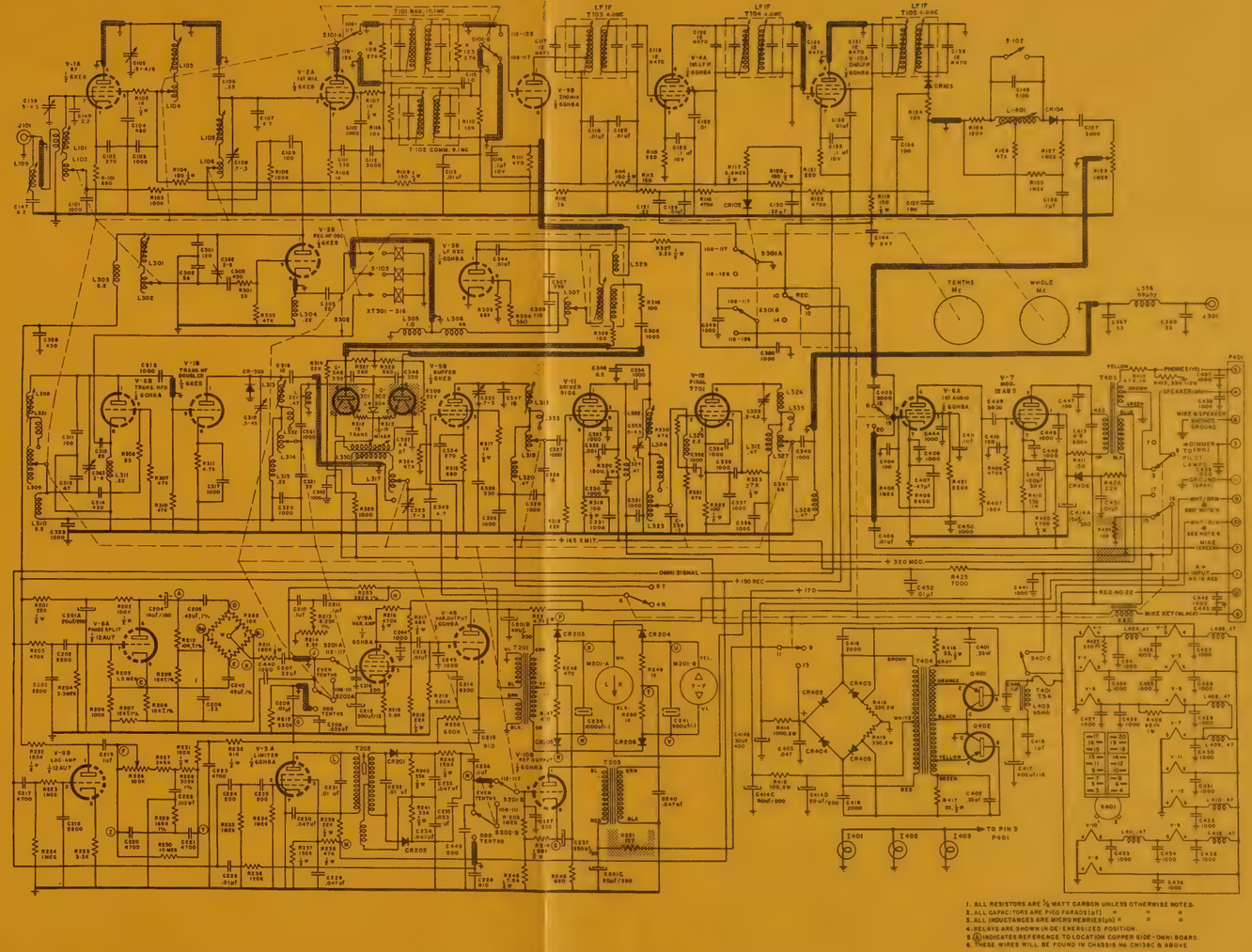
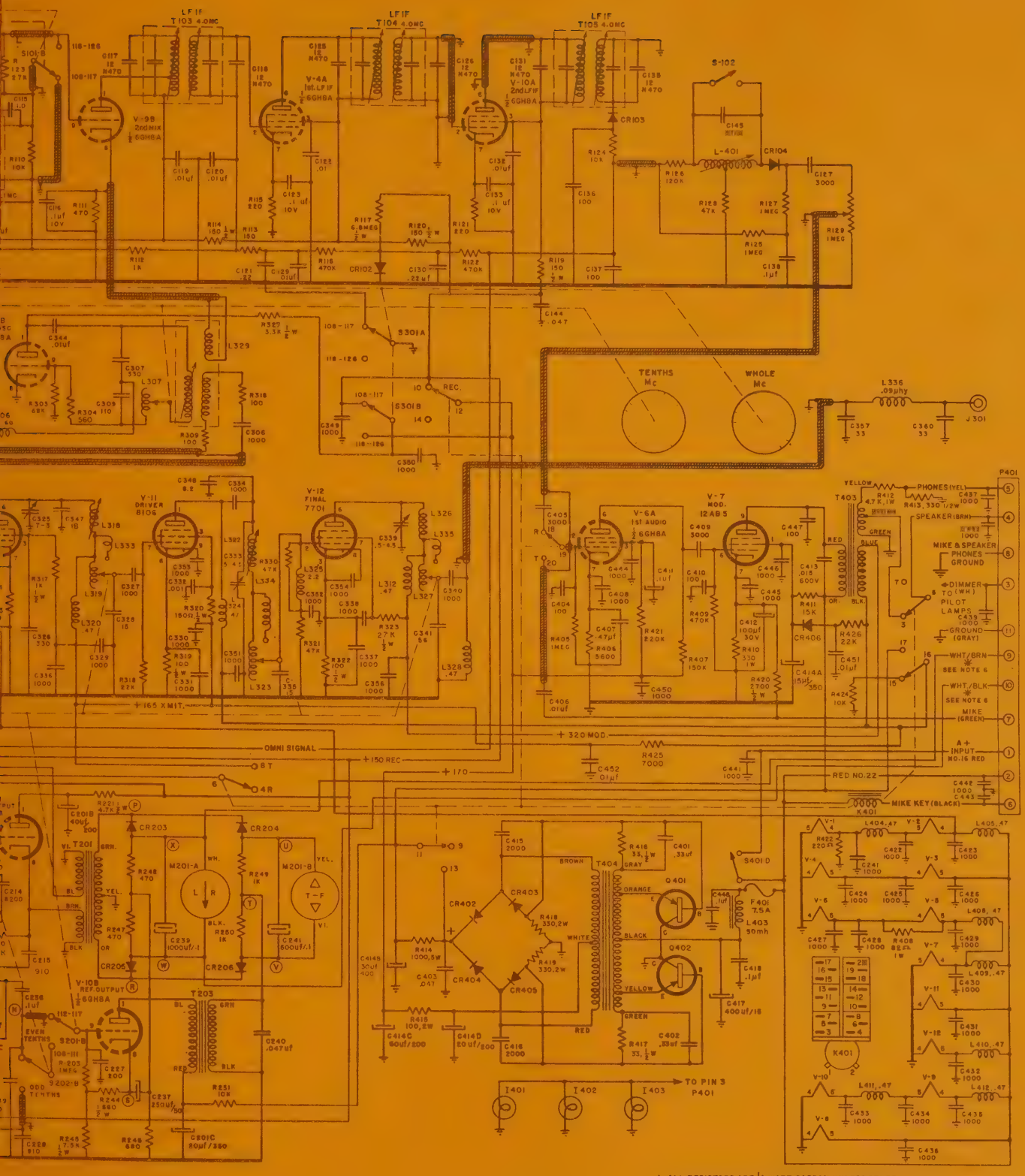

TENTHS Mc
WHOLE Mc
+165 XMIT
+320 MOD.
+150 REC
+170
OMNI SIGNAL
MIKE KEY (BLACK)
TO PIN 3 P401
1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) = = =
3. ALL INDUCTANCES ARE MICRO HENRIES (uh) = = =
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE - OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CH33/5 INC CN-138C & ABOVE

FIGURE 12. MARK 3, SCHEMATIC FOR CN-138-D-1



1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE - OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS NO. CN138C & ABOVE.

FIGURE 13. MARK 3, SCHEMATIC FOR CN-138-D-3

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-D3, Figure 13 of Supplement 3. (SUPERSEDED: SEE CN-138-D5.)

LFO circuit: A 15 pf disc capacitor (C-365) was added across L-301 to aid in minimizing 5 LFO energy from beating with receiver or transmit HFO thus causing "birdies".

C-365	24516-150	CAPACITOR, CERAMIC, DISC, 15$\mu\mu$f ±10%, 500V, NPO

"See Figure 8b for test points and service data."

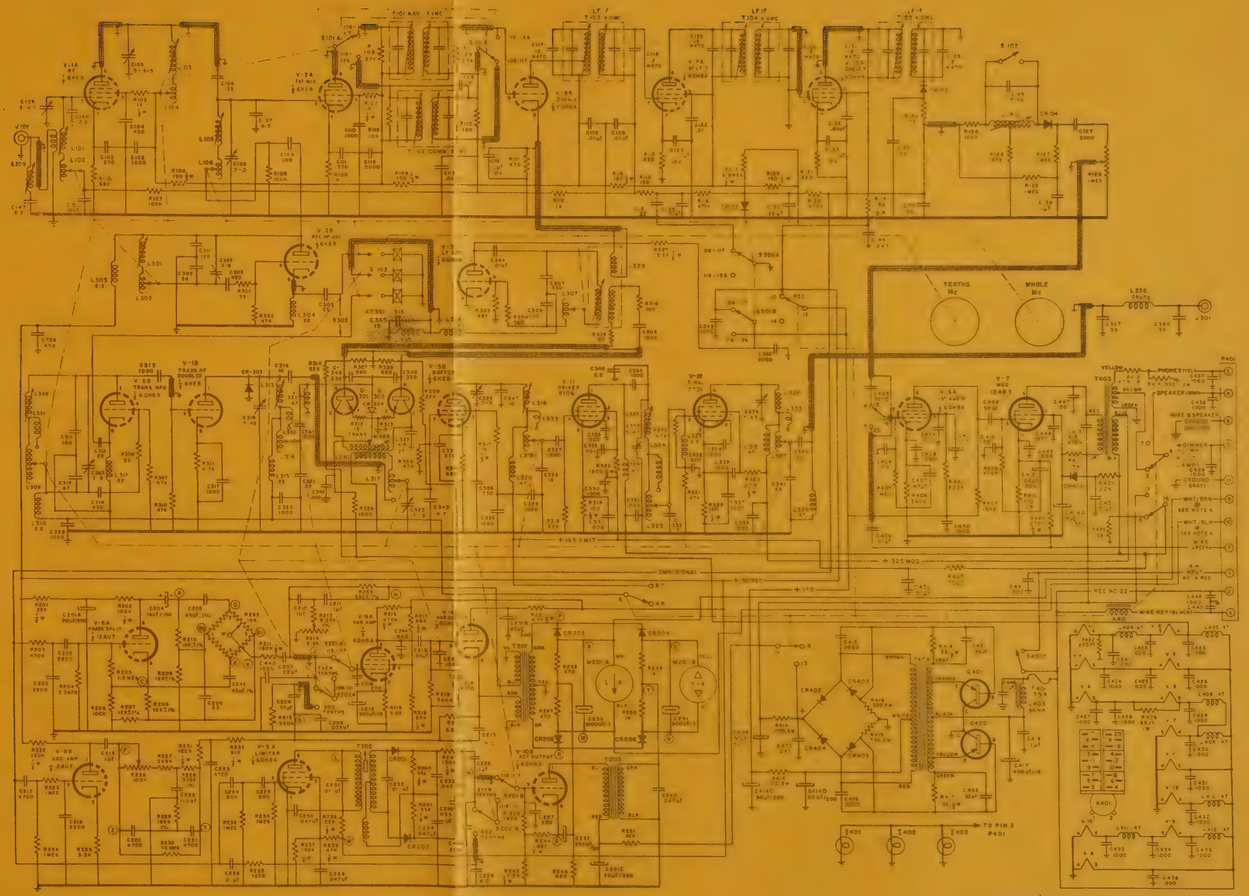
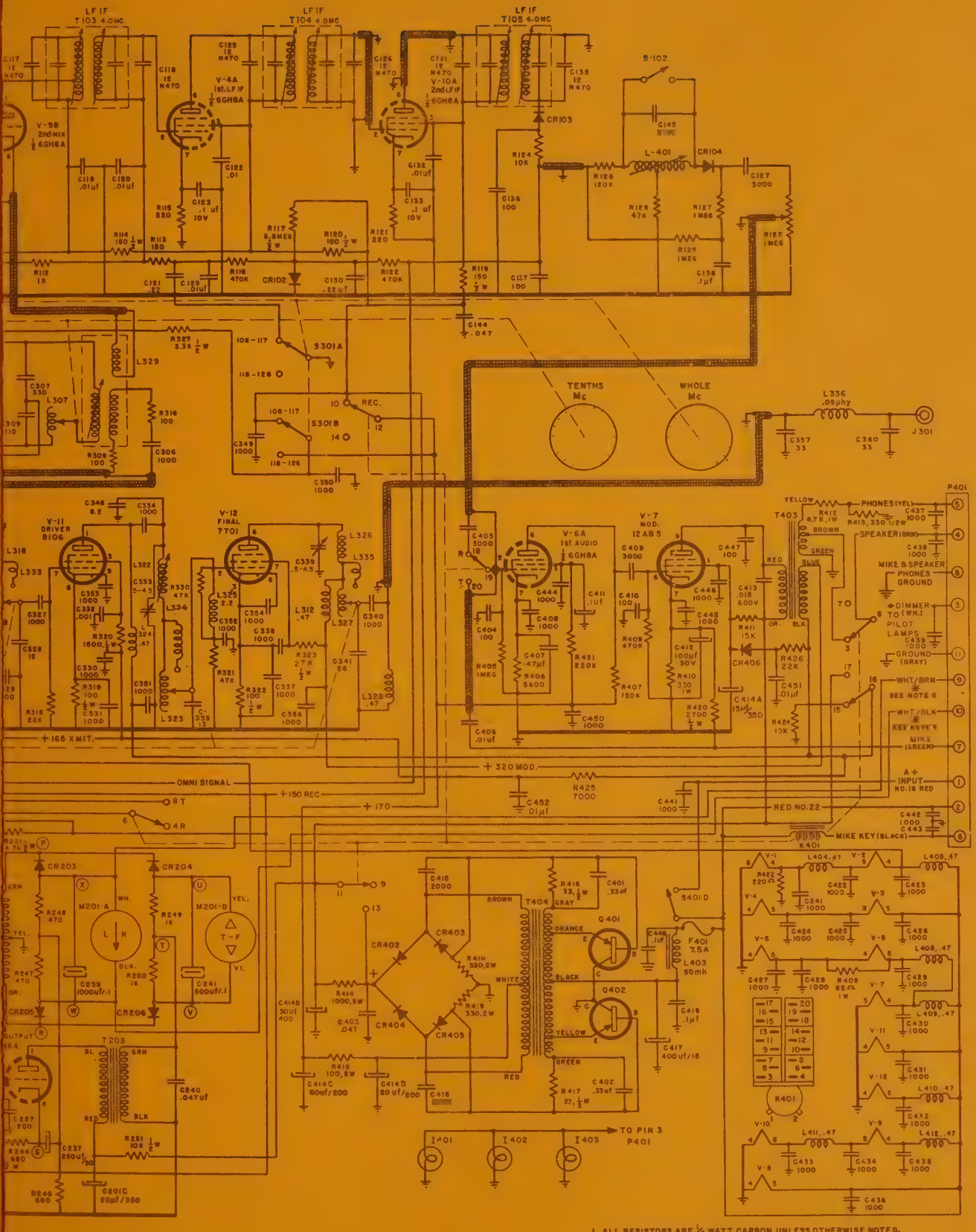

TENTHS Mc
WHOLE Mc
TO PIN 3 P401
1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICOFARADS (pf).
3. ALL INDUCTANCES ARE MICROHENRIES (μh).
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓖ INDICATES REFERENCE TO LOCATION COPPER SIDE - OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS No. CN138C & ABOVE

FIGURE 13. MARK 3, SCHEMATIC FOR CN-138-D-3



1. ALL RESISTORS ARE ¼ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE - OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS No. CN138C & ABOVE.

FIGURE 14. MARK 3, SCHEMATIC FOR CN-138-D-4

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-D4, Figure 14 of Supplement 3.

Localizer centering: To eleminate the need for localizer centering compensation and to increase L-R color at either limit of potentiometer (R-226), resistor (R-220) value changed to 1.5 mego and the compensation resistor across R-229 was removed. This change is applicable only to Chassis C-2 to D-3.

R-220	31192-155	RESISTOR, CARBON, 1.5 megohm ±10%, 1/4W

"See Figure 8b for test points and service data."

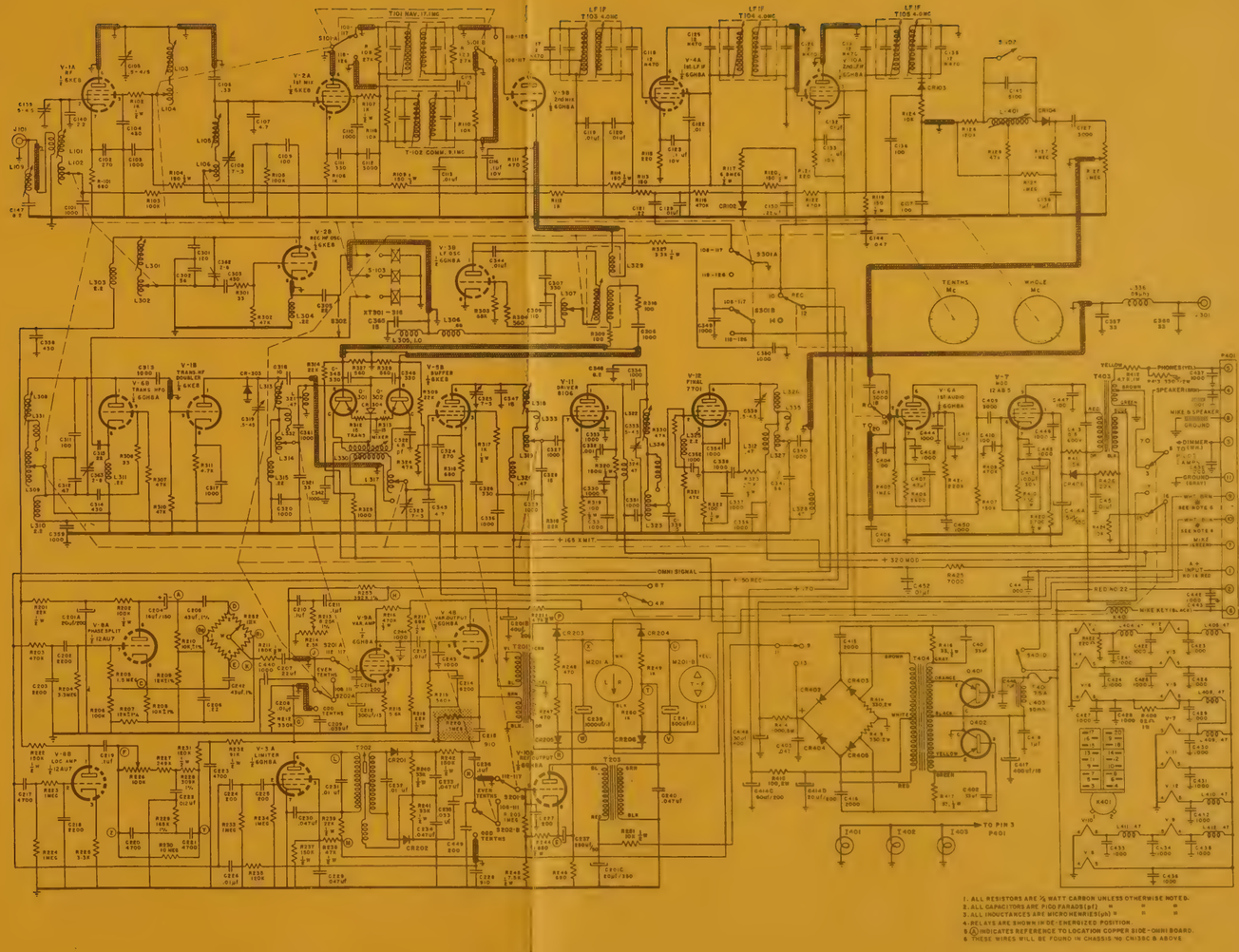
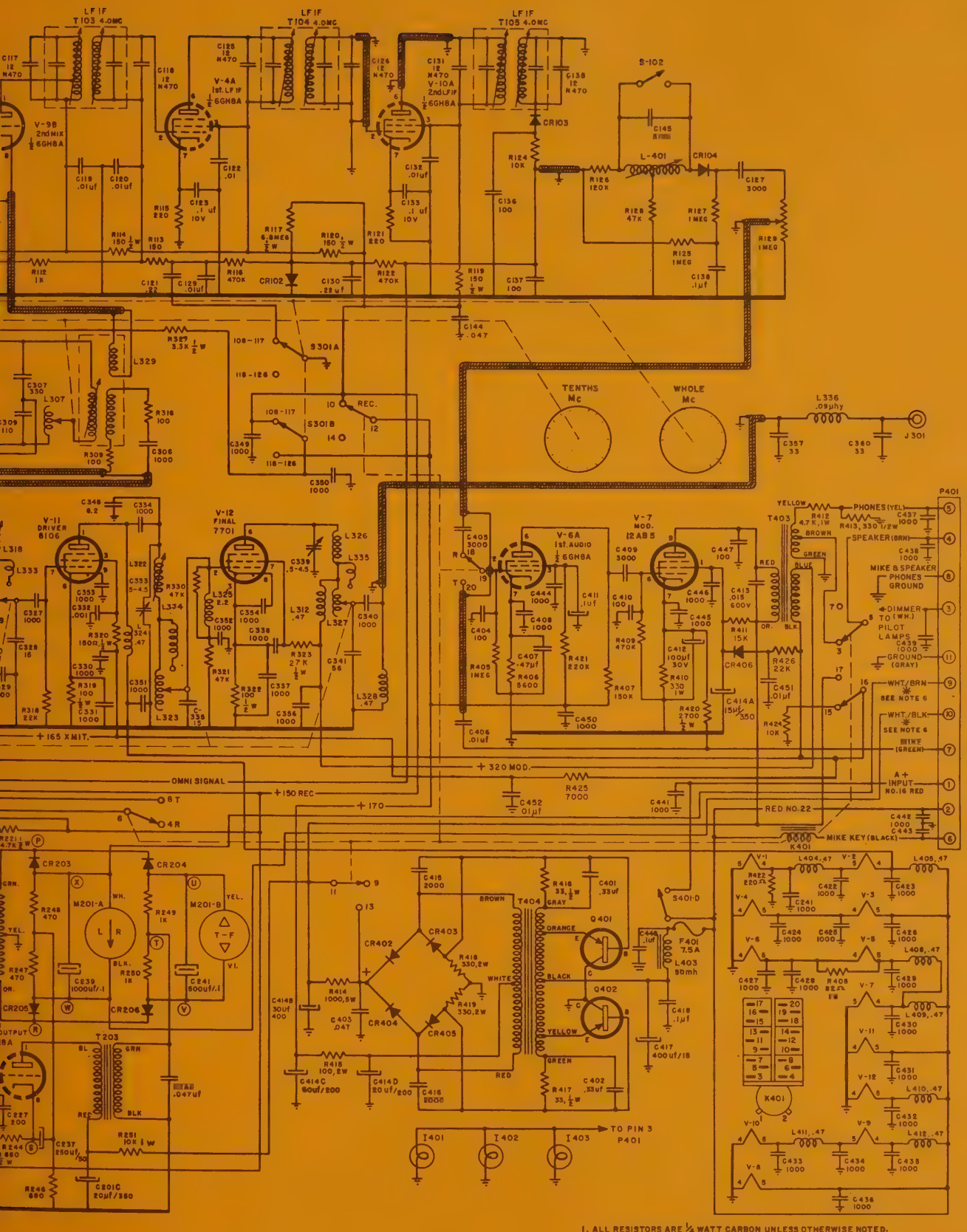


FIGURE 14. MARK 3, SCHEMATIC FOR CN-138-D-4



1. ALL RESISTORS ARE ¼ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICRO HENRIES (μh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS No. CN138C & ABOVE.

FIGURE 15. MARK 3, SCHEMATIC FOR CN-138-D-5

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-D5, Figure 15 of Supplement 3.

"THIS CHANGE SUPERSEDES THE ABOVE CN-138-D3 CHANGE."

To provide a more acceptable way to minimize 5 LFO frequency change value of L-306 to 2.2uh.

This change requires the removal of capacitor C-365 which was added across L-301 on chassis CN-138-D3, plus the change of L-306 noted above.

C-365	Deleted	
L-306	11138-9	RF Choke 2.2uh

"See Figure 8b for test points and service data."

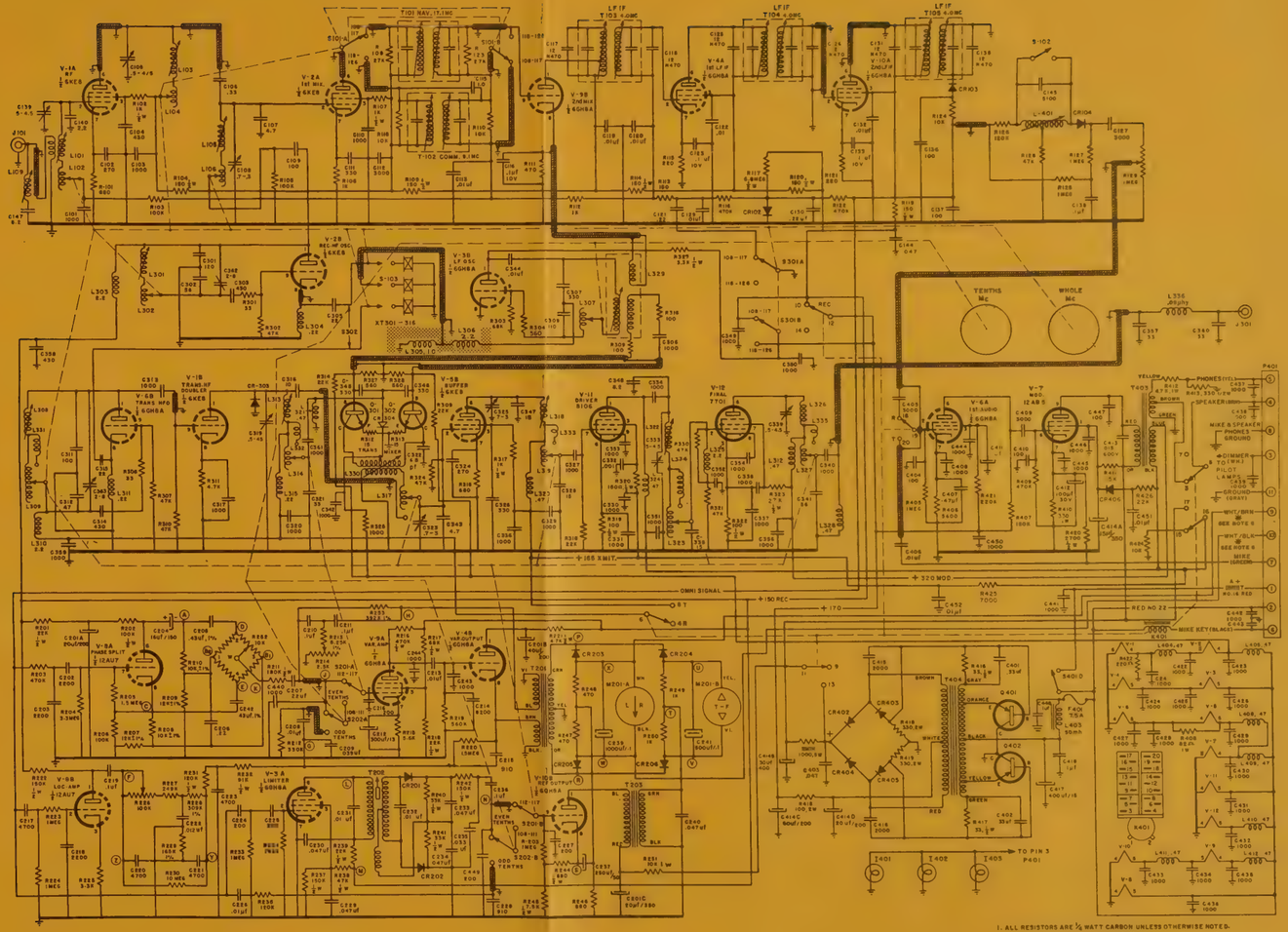
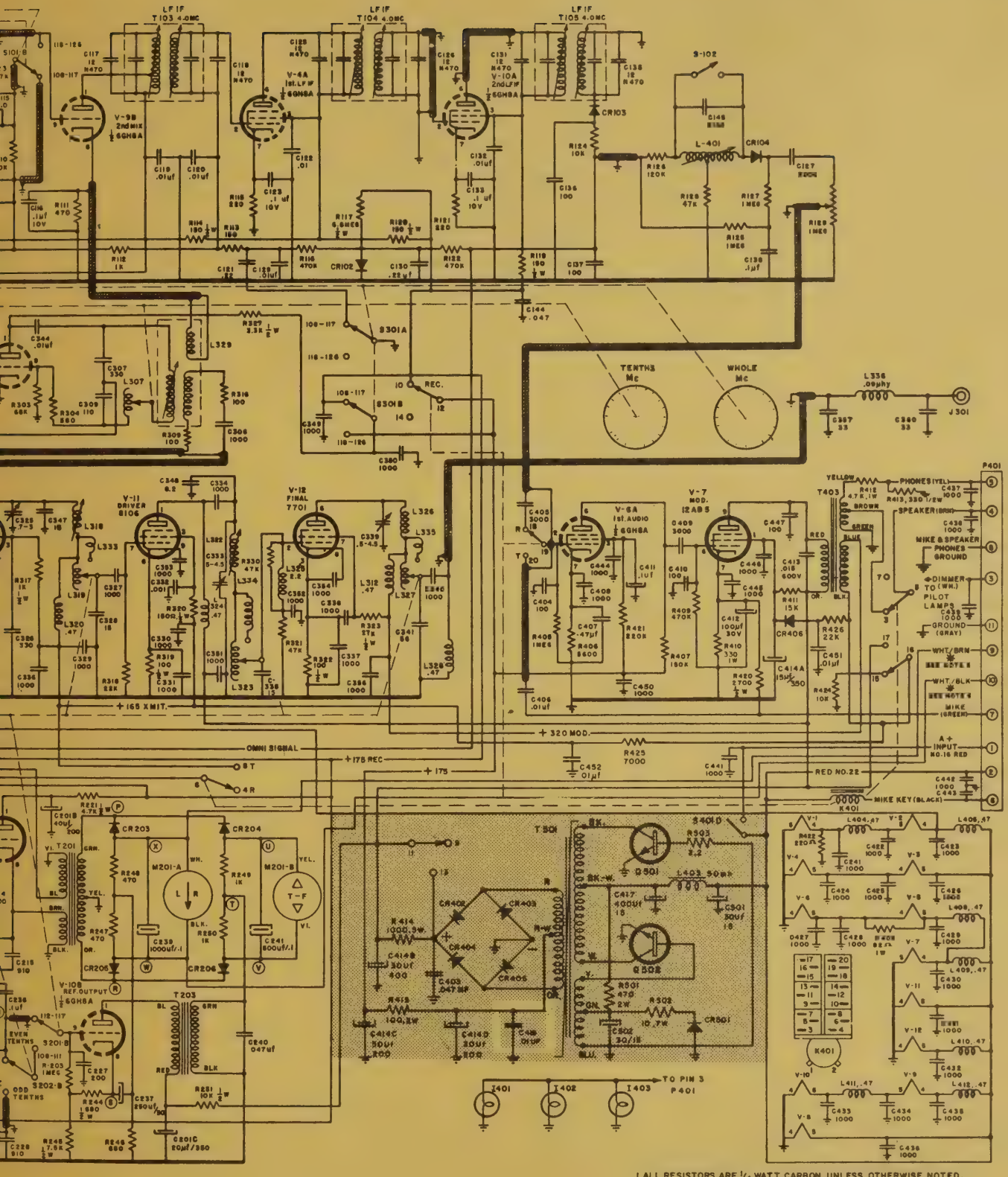

TENTHS Mc
WHOLE Mc
OMNI SIGNAL
+165 XMIT
+150 REC
+320 MOD
+170
TO PIN 3 P401
1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf).
3. ALL INDUCTANCES ARE MICROHENRIES (uh).
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS NO CN-136C & ABOVE

FIGURE 15. MARK 3, SCHEMATIC FOR CN-138-D-5



1. ALL RESISTORS ARE ¼ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICROHENRIES (uh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
✳ 6. THESE WIRES WILL BE FOUND IN CHASSIS NO. CN138C & ABOVE.

FIGURE 16. MARK 3, SCHEMATIC FOR CN-138-E and E-1

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN-138-E, Figure 16 of Supplement 4

The power supply circuit in the Mark 3 has been revised. The circuit now uses silicon power transistors in a DC to DC converter circuit operating at a frequency of approximately 6500 Hz.

The use of silicon transistors and an improved transformer material has resulted in a very efficient converter circuit. The B+ voltages supplied to the Unit are the same as in previous configurations. The new circuit components and those deleted are listed below:

Symbol	Action	Narco Part No.	Description
C-401	deleted		
C-402	deleted		
C-415	deleted		
C-416	deleted		
C-418	deleted		
C-448	deleted		
C-501	added	21552–18	CAPACITOR, Electrolytic, 30 μf, 15v
C-502	added	21552–18	CAPACITOR, Electrolytic, 30 μf, 15v
CR-501	added	75204-45	DIODE, Silicon, 500v, PIV
Q-301	Type Substitution	75568-2	TRANSISTOR
Q-302	Type Substitution	75568-2	TRANSISTOR
Q-401	deleted		
Q-402	deleted		
Q-501	added	75564-2	TRANSISTOR, Power Silicon
Q-502	added	75564-2	TRANSISTOR, Power Silicon
R-416	deleted		
R-417	deleted		
R-418	deleted		
R-419	deleted		
R-501	added	31136-471	RESISTOR, Carbon, 470Ω ±10%, 2w
R-502	added	31190-6	RESISTOR, Wirewound, 10Ω ±5%, 7w
R-503	added	31141-229	RESISTOR, Carbon, 2.2Ω ±10%, ½w
T-404	deleted		
T-501	added	11697-3	TRANSISTOR, Power

CN-138-E1, Figure 16 of Supplement 4
To minimize RFI caused by rectifier diodes, an additional by-passing of the B+ line was added.

C-419	added	21291-6	CAPACITOR, Ceramic Disc, .01mf, 500V, GMV

Schematic Update:
Corrected FROM: B+ lead to Pin 3 of V-1A plate and screen feed point were in parallel.
Corrected TO: Screen B+ now fed from junction of R109 and R-114.
This adjustment to the schematic reflects past and current MK-3's.

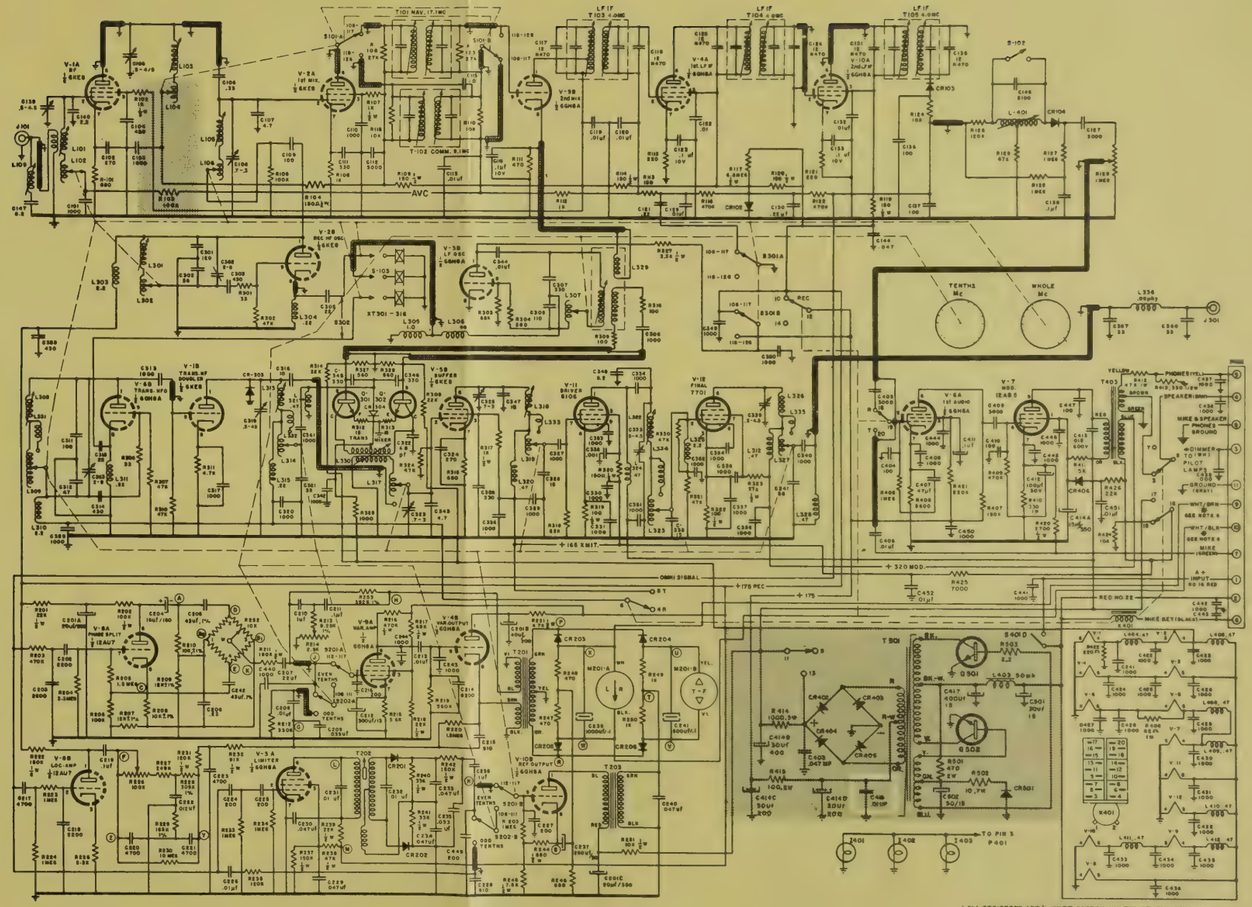
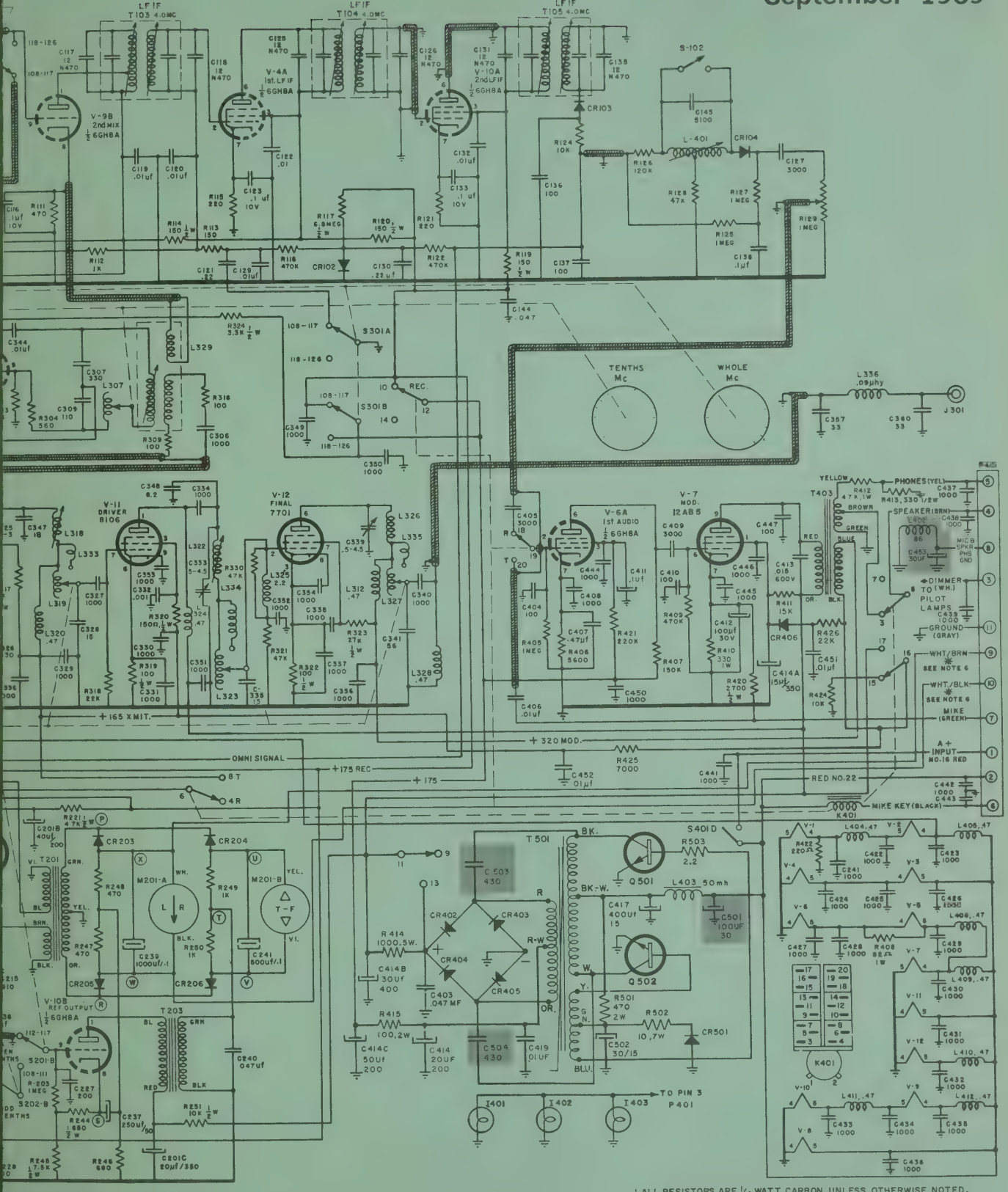

TENTHS Mc
WHOLE Mc
AVC
+165 XMIT
+320 MOD.
+175 REC
OMNI SIGNAL
1. ALL RESISTORS ARE ½ WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS(pf) " " "
3. ALL INDUCTANCES ARE MICROHENRIES(uh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (X) INDICATES REFERENCE TO LOCATION COPPER SIDE OMNI BOARD.
* 6. THESE WIRES WILL BE FOUND IN CHASSIS NO. CN138C & ABOVE.

FIGURE 16. MARK 3, SCHEMATIC FOR CN-138-E and E-1



1. ALL RESISTORS ARE 1/4 WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICROHENRIES (uh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
✳ 6. THESE WIRES WILL BE FOUND IN CHASSIS NO. CN138C & ABOVE.

FIGURE 17. MARK 3, SCHEMATIC FOR CN-138-E2

R-02245-H

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN138E-2

To reduce power supply harmonic interference in receiver and to reduce RFI on A+ Line:

Changed L303 11138-0019 CHOKE, RF, 15μh
Changed C501 21554-0004 CAPACITOR, Electrolytic, 100μf, 30V
Changed C322 24516-0229 CAPACITOR, Ceramic Disc, 2.2pf ±10%, 500V
Changed C343 24516-0339 CAPACITOR, Ceramic Disc, 3.3pf ±.25pf NPO, 500V

Added C503 21291-0025 CAPACITOR, Ceramic Disc, 430pf ±10%, 500V
Added C504 21291-0025 CAPACITOR, Ceramic Disc, 430pf ±10%, 500V

To reduce RFI on ADF frequencies conducted via audio ground circuit:

Added L402 11138-0025 CHOKE, RF, INSULATED, 86μh ±5%
Added C453 21558-0004 CAPACITOR, Electrolytic, 30μf, 15V

Corrected schematic:
R324 was R329
R329 was R324

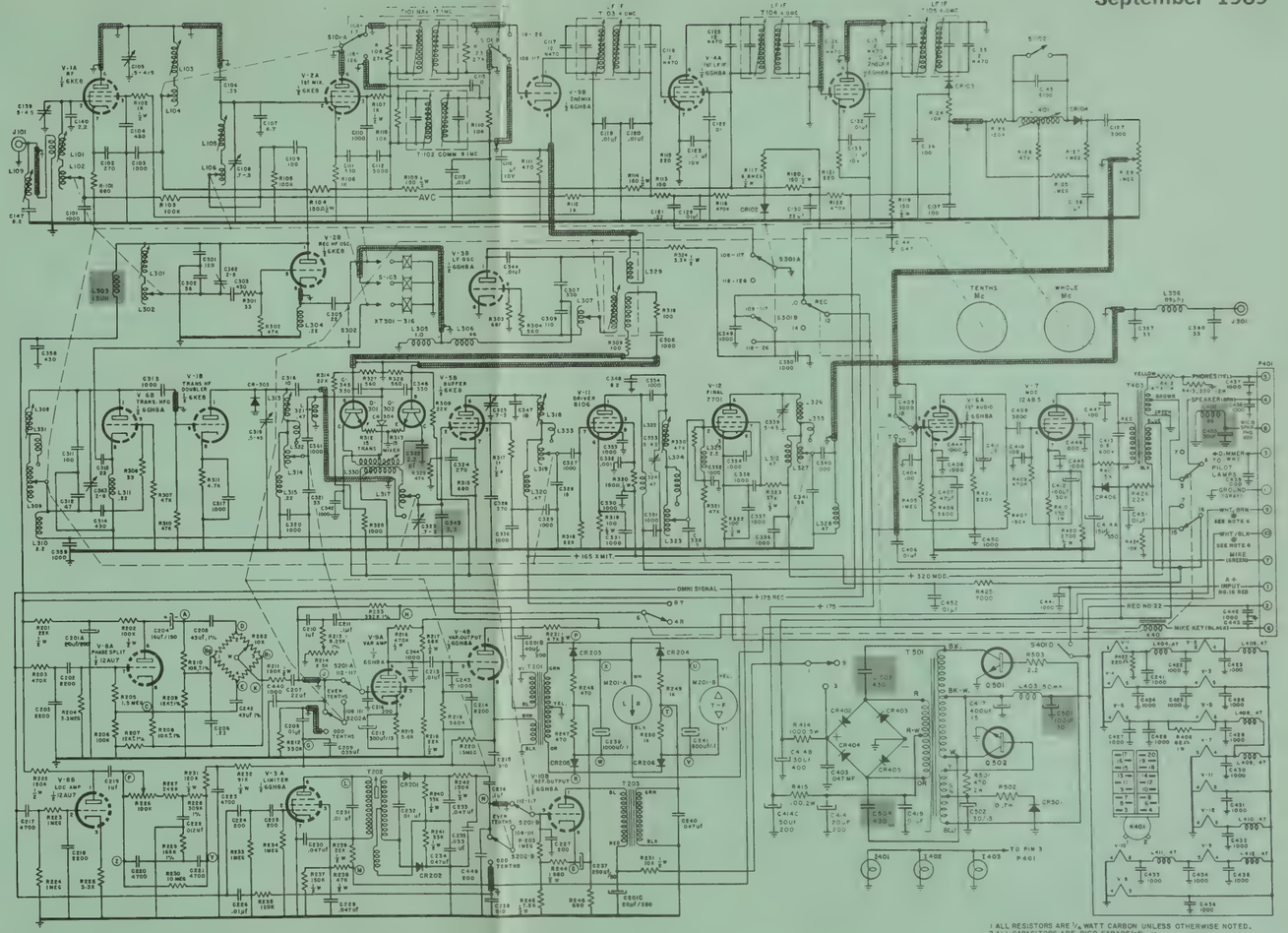
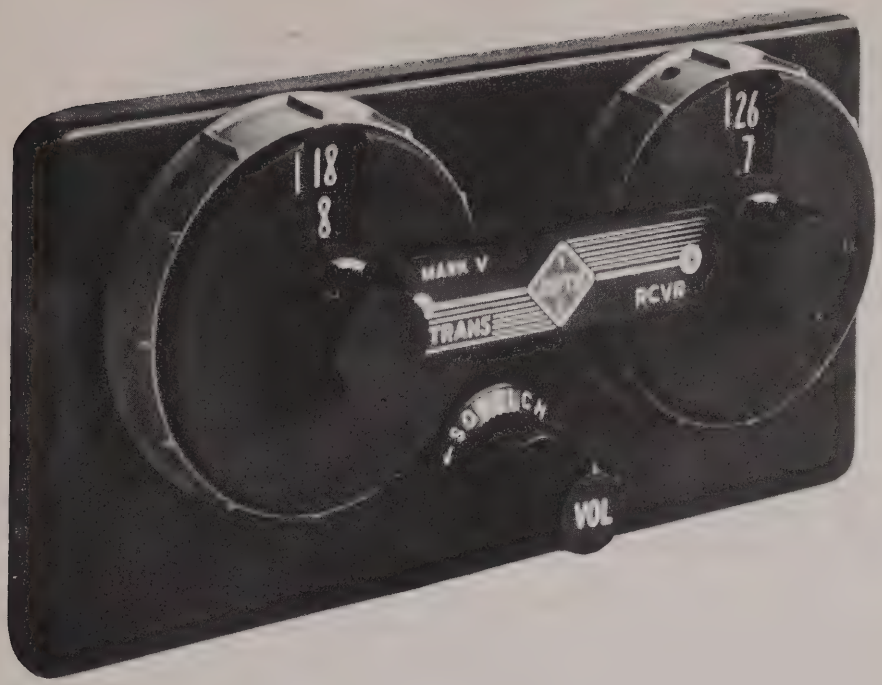

1. ALL RESISTORS ARE 1/2 WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) " " "
3. ALL INDUCTANCES ARE MICROHENRIES (uh) " " "
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. Ⓐ INDICATES REFERENCE TO LOCATION COPPER SIDE-OMNI BOARD.
6. THESE WIRES WILL BE FOUND IN CHASSIS NO. CN136C & ABOVE.

FIGURE 17. MARK 3, SCHEMATIC FOR CN-138-E2

R-02245-H

Mallinckrodt
ST. LOUIS, MO.



NARCO

MARK V

with CN50C, CN50G, CN50K, CN50J

OPERATION · INSTALLATION and SERVICE MANUAL

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Warranty

We have designed and constructed this equipment using the finest materials and components available. It has been thoroughly tested and inspected before leaving our factory.

NARCO warrants your new MARK V and T( )MP-7 against all defects in workmanship or material on components and parts manufactured by us for a period of ninety (90) days from the date of original installation. We will replace any part of our manufacture which proves to be defective within this time under normal installation and operating conditions (except fuses and receiving-type tubes), provided the defective part is returned, transportation charges prepaid, either to the factory or to a NARCO Authorized Warranty Service Center.

To place your warranty in effect you must complete the enclosed Warranty Application Card and mail it to us within ten (10) days after your new installation is completed. By return mail you will receive your NARCO Warranty Certificate, recognized by any NARCO Authorized Service Agency.

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
Fort Washington • Pennsylvania

Perfection in Electronics

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SECTION I

INTRODUCTION AND OPERATION

A. GENERAL DESCRIPTION

The NARCO MARK V is a crystal-controlled VHF receiver and transmitter designed to provide two-way voice communications between aircraft and ground stations, or between aircraft in flight, and to provide VOR/LOC navigation reception with the addition of a suitable navigation converter, such as the NARCO VOA-3A. Ninety crystal-controlled transmitter channels provide coverage every 100 Kc. from 118.0 to 126.9 Mc. One hundred and ninety crystal-controlled receiver channels, from 108.0 to 126.9 Mc., provide reception of the communication and navigation range.

A separate unit, the NARCO T(-)MP-7 Transistor Modulator-Power Unit provides audio amplification and modulation, and supplies all power required by the MARK V.

B. SPECIFICATIONS

1. RECEIVER

a. Frequency Coverage—190 channels, 108.0 to 126.9 Mc., 100 Kc. steps.

b. Sensitivity—1.5 microvolts, modulated 30% at 1000 cps. for 1 watt output, 6 db signal plus noise to noise ratio.

c. Bandwidth—42 Kc., 6 db down; 160 Kc., 60 db down.

d. Image Rejection — 80 db minimum; double conversion superheterodyne.

e. AVC—Within 3 db, 10-10,000 microvolts. Time constant automatically changed to suit navigation signals on channels below 118.0 Mc.

f. Audio Response—Within 3 db from 350 to 2500 cps.

g. Noise Limiter—Series—shunt type.

h. Squelch—Audio adjustable; front panel control concentric with volume control.

i. Audio Output—Up to 5 watts; 3 ohm speaker and dual 600 ohm headsets.

2. TRANSMITTER

a. Frequency Coverage—90 channels, 118.0 to 126.9 Mc., 100 Kc. steps.

b. Frequency Stability—Within 0.01%, crystal-controlled.

c. RF Power Output—5 watts, nominal.

d. Modulation—100%, with 8-10 db speech compression.

e. Sidetone—Up to 100 milliwatts.

f. Microphone—Standard carbon or noise- cancelling.

3. TRANSISTOR MODULATOR POWER UNIT—T(-)MP-7

a. Type—Transistorized, with toroid power transformer; provides power for transmitter, receiver, and accessory units (VOA-3A Omni Converter and LFR-3 Receiver).

b. Control—Transmit-Receive relay, operated by microphone switch.

c. Filtering—LC filter networks insure clean, hum-free operation.

d. Fuses—10 Ampere, slow-blow (13.75v.), 6.25 Ampere, slow-blow (27.5v.).

e. Modulation — Three transistors provide audio for 100% modulation to transmitter. Screwdriver-adjusted control compensates for different microphones.

4. GENERAL INFORMATION

a. Weight — Transmitter and Receiver Unit — 6 lbs. Power Supply T(-)MP-7 — 3.5 lbs.

b. Size—Transmitter and Receiver Unit—3" H. x 6-9/32" W. x 12" L. Power Supply T(-)MP-7—6-3/8" x 3-5/8" x 4-1/2".

c. Power Drain—13.75 Volts: 6.5 Amp., Receive; 8.5 Amp., Transmit. 27.5 Volts: 3.3 Amp., Receive; 4.3 Amp., Transmit.

d. Voltage Changeover—Panel units interchangeable for 13.75/27.5 Volts.

e. Accessories—Provision for powering VOA-3A Omni Converter and LFR-3 Low Frequency Receiver.

TRANSMITTER CHANNEL SELECTOR SHOWN SET AT 121.1 MC.

SQUELCH CONTROL CONCENTRIC WITH ON/OFF-VOLUME CONTROL

RECEIVER CHANNEL SELECTOR SHOWN SET AT 119.3 MC.

Figure 1.

C. OPERATION

1. ON/OFF—VOLUME CONTROL

The small outer knob marked "VOL" controls the receiver audio level and also serves as the power on-off switch. Rotating this knob clockwise from the OFF position applies primary power to the set; by further advancing the control, the loudness of the received signals is increased. The volume setting does not affect navigation signals.

2. SQUELCH

The inner knob marked ' 'SQUELCH" controls the squelch circuit, used to eliminate receiver background noise when no signal is being received, or eliminate undesirable weak signals while receiving. This knob should be turned counterclockwise to the point where any objectionable RF noise interference or weak signals just disappears; a signal that is stronger than the noise will "break" the squelch and be heard at the receiver output. This setting will vary with the different levels of interference encountered. Too high a setting (counter-clockwise) in a low noise area, can result in missing a weak signal that otherwise might be heard. Squelch can be used for navigation reception, but care should be taken to insure that weak omni audio indentification signals are not missed by to high a setting. Receiver operation may be checked at any time by "opening" the squelch so that the background noise and hiss can be heard.

3. RECEIVER CHANNEL SELECTION

Select the desired receiving channel by turning the large inner knob of the right hand channel selector until the correct megacycle channel appears in the window, then turning the small outer knob until the correct tenth-megacycle channel appears just below. In this manner, any one of 190 crystal-controlled channels may be selected.

4. TRANSMITTER CHANNEL SELECTION

Selection of the desired transmitting channel may be accomplished by using the left-hand (transmitter) channel selector knobs in the same manner as for receiver channel selection. Any one of 90 crystal-controlled channels may be selected.

Either simplex or cross channel operation is possible, by selecting the same or different transmitting and receiving channels. The transmitter is placed in operation by pressing the push-to-talk switch on the microphone; relays in the power-modulator unit and the panel unit are controlled by this switch. Allow a sufficient filment warm-up period, when the set is turned on, before keying the transmitter.

D. LICENSE NOTICE

The Federal Communications Commission requires that the operator of this transmitter hold a Restricted Radio-Telephone Operator Permit, or higher class license. This permit may be obtained by any U. S. citizen from the nearest field office of the F.C.C.; no examination is required.

The transmitter itself, as installed in the aircraft, requires a Private Aircraft Radio Station License. This license is obtained by filling F.C.C. Form 404. Technical data is on file with the F.C.C. under the heading, NARCO MARK V.

SECTION II

INSTALLATION

A. EQUIPMENT INITIALLY SUPPLIED BY NARCO

1. MARK V VHF communications equipment, in case and with mounting brackets.
2. Transistor-Modulator-Power Unit T(-)MP-7, with mounting plate.
3. Connectors:
   a. Receiver antenna plug, Narco Part No. 41237-1 & 2.
   b. Transmitter antenna BNC connector, Narco Part No. 41152-1.
   c. Cable connector, (AN-3016A-20-29S), Narco Part No. 41233 3.
   d. Cable clamp, Narco Part No. 41228-6.
   e. Cable connector assembly, Narco Part No. 41240-101.
4. Tools:
   a. Hex wrench for front panel knobs, Narco Part No. 84045-3.
   b. Hex wrench for internal gears, Narco Part No. 84045-2.

B. EQUIPMENT AVAILABLE FROM NARCO

1. Power cable—Narco Part No. 90550. Eight foot length with accessory connections.
2. Antennas:

   Communications—

   a. VSAC-1, Sapphire Communications Antenna, Narco Part No. 71144-103.
   b. VTP-17, Communications Antenna, Narco Part No. 71111.

   Navigation—

   a. VRP-15A, Mast-type VOR receiving antenna, Narco Part No. 71151.
   b. VRP-37, fin-mounting VOR receiving antenna, Narco Part No. 71126.
3. Accessories—

   Narco Model VOA-3A Omni Converter.
   Narco Model LFR-3 or 3L Low Frequency Receiver.

C. EQUIPMENT REQUIRED, BUT NOT SUPPLIED BY NARCO

1. Headphones—low impedance type, 300 to 1000 ohms.
2. Loudspeaker—4 to 15 ohms nominal voice coil impedance.
3. Low impedance carbon microphone, noise-cancelling type is recommended, such as Electro Voice Model L205KK or Telephonics RS38D2, with push-to-talk switch.
4. Headphone and microphone jacks.

D. INSTALLATION INSTRUCTIONS

1. TRANSMITTER-RECEIVER UNIT (MARK V)

a. A rectangular opening, 6-1/8" wide by 3" high, should be provided in the instrument panel. Refer to the installation diagram (fig. 2).

b. With the set removed from the case, install the case in this opening using the mounting flanges provided, and machine screws and stop-nuts. The front of the case should extend in front of the panel about 5/16".

c. Install a rear support from the stud on the rear of the case to some nearby structural member. Allow sufficient space behind the case for cables, and for access to the air-lock fastener.

d. Slide the set into the case, feeding the pigtail cable through the cutout, and secure with a quarter turn of the air-lock fastener on the rear of the case.

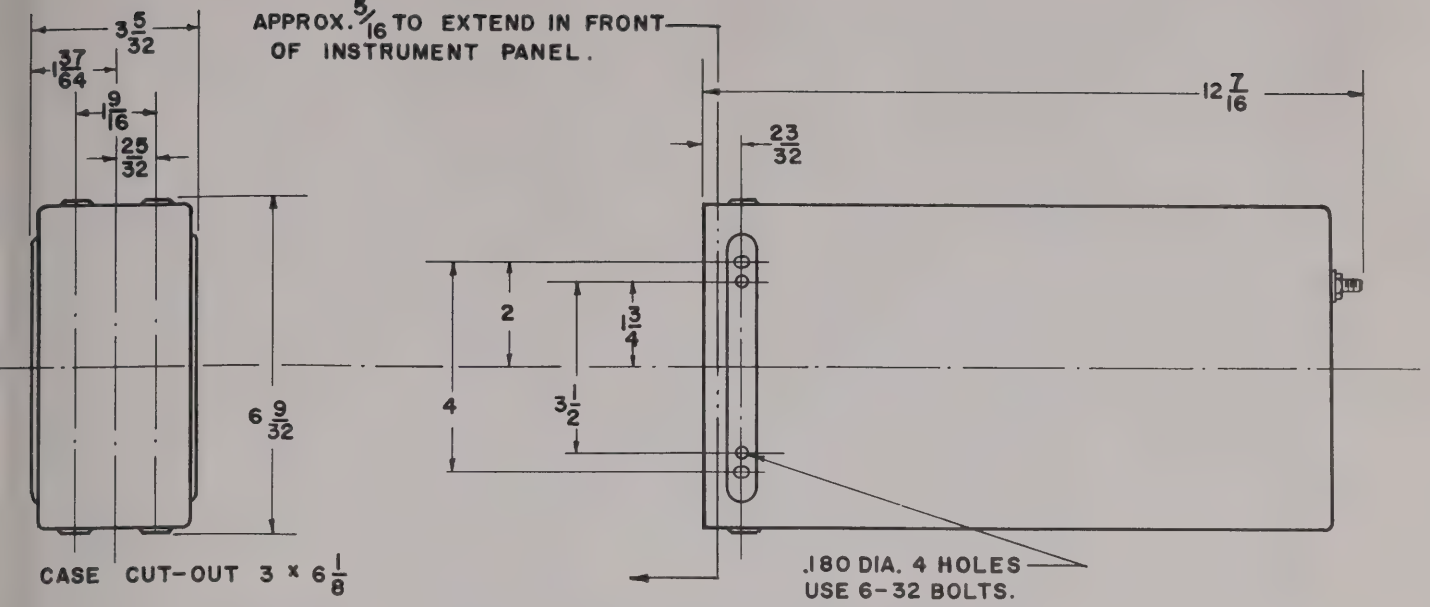
2. TRANSISTOR MODULATOR-POWER UNIT (T(-)MP-7). (Figure 2).

a. Fasten the power unit mounting plate to either a vertical or a horizontal surface using four #10 machine screws and stop-nuts.

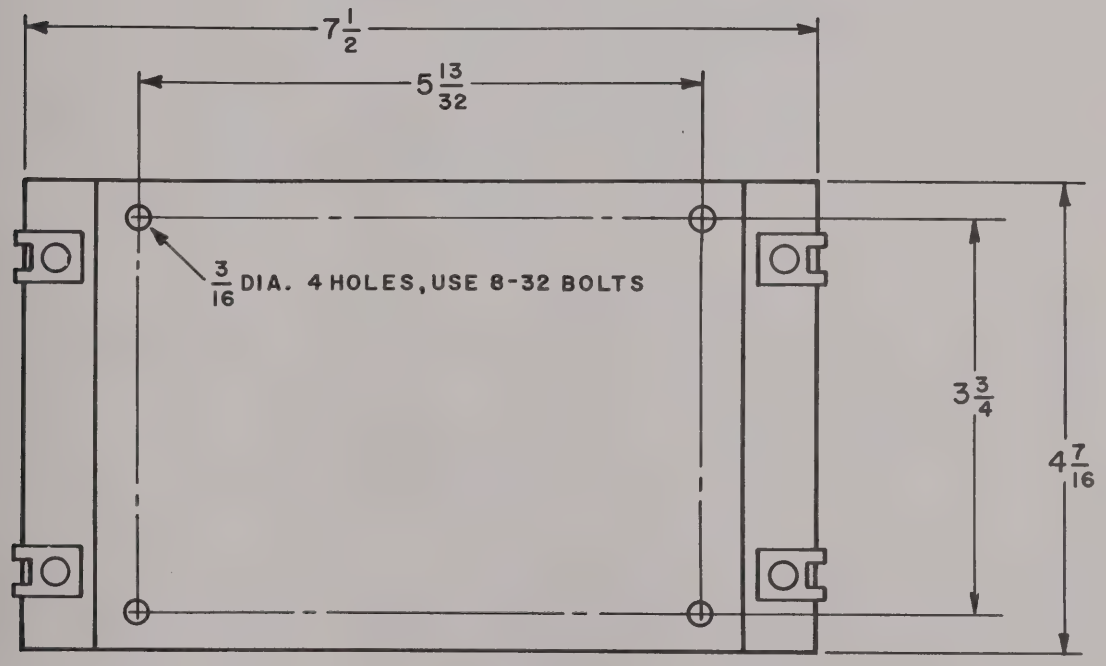
b. Attach the two power unit mounting brackets to the power supply.

c. Start the four power unit mounting screws into the mounting plate, leaving approximately 1/8" between their heads and the "U" nuts on the plate.

d. Slide the power unit into place, and move it to the proper side to engage the mounting screws in the slots provided for them; tighten the mounting screws.



TRANSMITTER-RECEIVER UNIT—MOUNTING DIMENSIONS



ALLOW SPACE FOR CONNECTORS AND CABLES

T( ) MP-7 MODULATOR-POWER UNIT MOUNTING DIMENSIONS

Figure 2.

E. ANTENNAS

1. COMMUNICATION

Any of the NARCO vertical or bent whip antennas may be used with the MARK V for communications: Sapphire VSAC-1, or VTP-17. If a suitable antenna switching relay is provided, one antenna can be used for both receive and transmit; separate antennas may be used for each function.

The VSAC-1 Sapphire Communications Antenna is designed for installation on the external airframe surface in as flat and unobstructed an area as possible. Mounting dimensions are shown in figure 3. The antenna RF coaxial cable should be RG-58A/U using BNC coaxial fittings. The following precautions should be observed in RF cable installations.

1. Keep the antenna cable as short as possible.
2. Do not bend the cable in a radius of less than 2 inches.
3. Use extra care in assembling and soldering UG-88/U connectors, especially noting that the center "needle" pin is flush with the plane of the UG-88/U shell flange.

When the transmitting and/or receiving antenna to be used is a VTP-17, it should be mounted on a metal plate measuring at least 18" square; such a mounting plate is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface exists, a thin piece of aluminum may be affixed flush with the fabric. A 7/16" hole is required in the mounting plate for the antenna insulator, which should be arranged with the male portion of the insulator protruding out from the inside of the aircraft.

Do not lengthen or shorten the antenna, as it has been cut to the proper length for most efficient radiation at the frequencies used. The antenna(s) should be located at least 12" from other objects on the surface of the aircraft, and should not have other wires or devices connected to it.

2. NAVIGATION

In installations where an omni converter is to be used with the MARK V receiver, **a horizontally polarized antenna is absolutely necessary,** in order that the full range and accuracy of the VHF omnirange system can be realized. Either a pedestal-type or a tail-mounting antenna may be used, such as the NARCO VRP-15A or the VRP-37.

The location of the antenna is also of paramount importance. It is advisable to place it on the top of the airplane behind the cockpit and well away from the engine(s) and propellor(s). Other antennas and wires located within two feet of the omni antenna may cause weak reception from some directions, and should be avoided. The rods should be horizontal in level flight attitude.

The VRP-15A antenna has a built-in balun, made of a special transmission cable cut to critical dimensions, and should not be disturbed. If the mast is not used (as the VRP-37), this balun must be installed between the antenna and the cable to the set. Ground all coaxial sheaths at the point where the balun connects to the set cable.

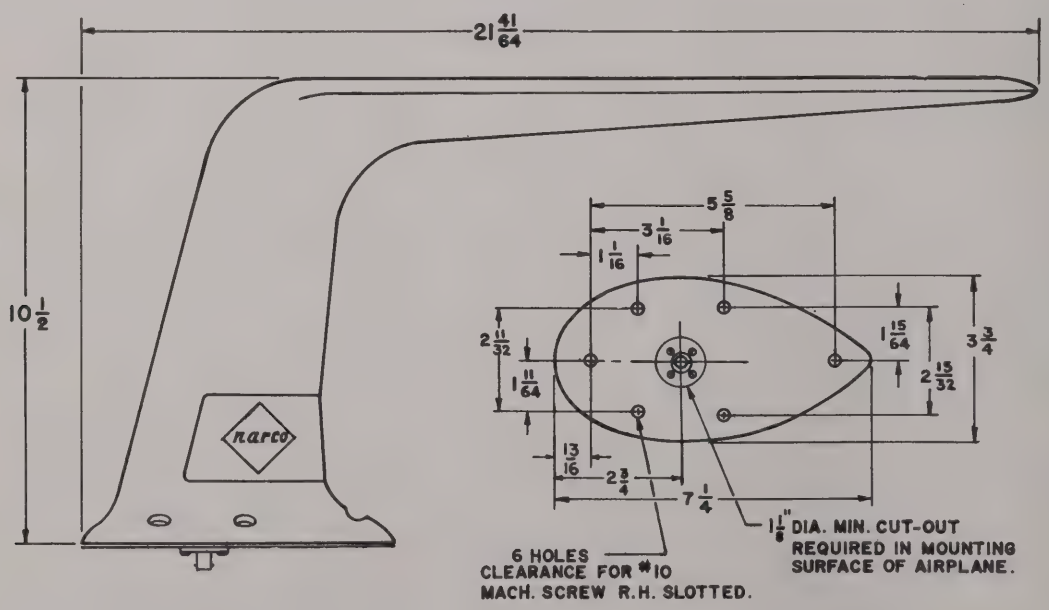


Figure 3. VSAC-1 ANTENNA — MOUNTING DIMENSIONS

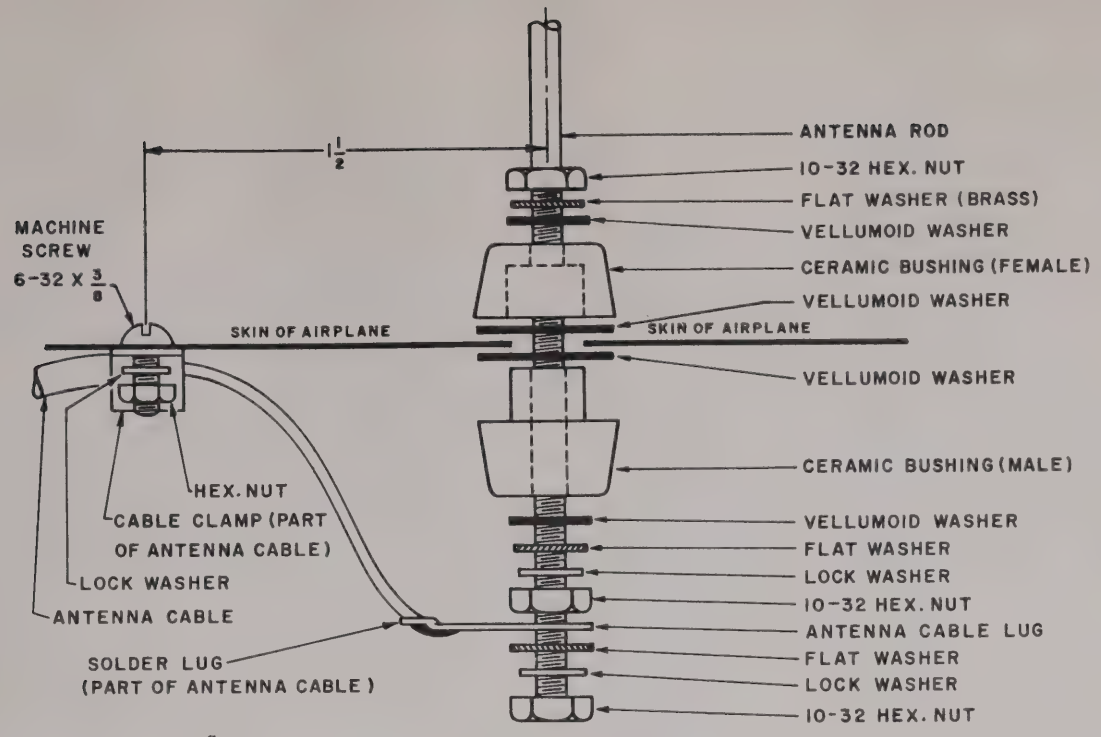


Figure 4. TRANSMITTING ANTENNA — MOUNTING DIAGRAM

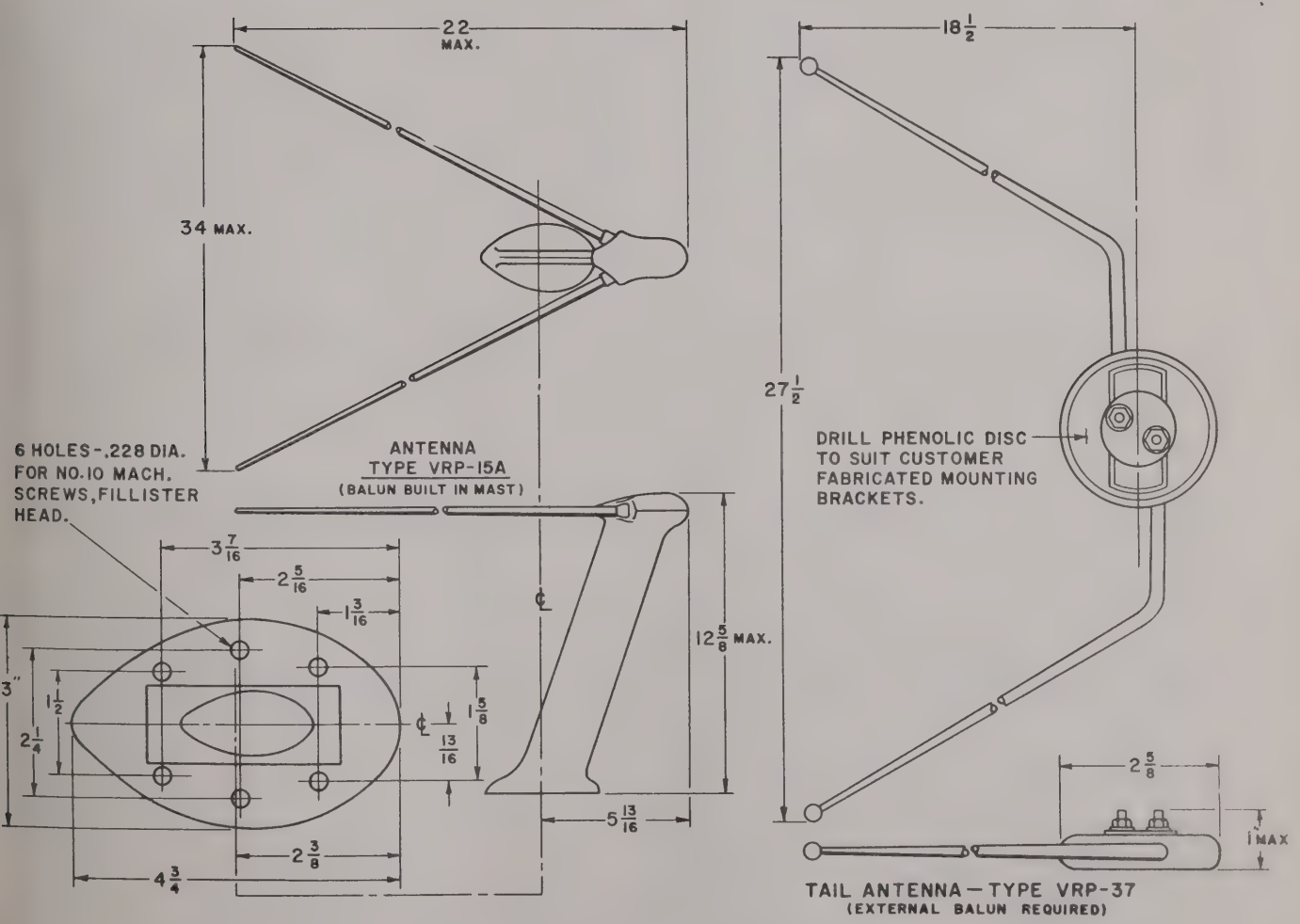


Figure 5. RECEIVING ANTENNA — MOUNTING DIAGRAM

F. CABLING INSTRUCTIONS

1. WIRING CONSIDERATIONS

The basic cabling diagram (fig. 7) shows the wiring of the connections between the power-modulator unit and the panel-mounted transmitter and receiver unit. Un-insulated microphone and headphone jacks may be mounted conveniently on the aircraft panel, and wired into the power-audio cable. By bringing an A-plus lead, controlled by the Mark V power switch, out (from the power cable) with these jacks, the NARCO VP-9 SWITCH-MASTER may be used in conjunction with the Mark V. Note that provision has been made for the wiring of an external panel light dimmer, should such be desired. Operating voltage change-over is accomplished by the proper wiring of the **cable** and selection of the proper voltage power supply-modulator unit. The Mark V panel unit is interchangeable for 13.75 or 27.5 volt operation. The 6 inch pigtail lead on the T(-)MP-7 Power-Modulator Unit should be grounded to the airframe at the power supply mounting plate. To avoid trouble in fabricating the cable, the following details and precautions should be observed.

1. A #16 wire is used to connect pin "E" and pin "K" of the rectangular plug (41240-101) to pin "H" of the "AN" connector (41233-3). Divide this wire at one end and connect one half to pin "K" and the other half to pin "E" of 41240-101.
2. A #20 wire is used to connect A-plus from pin "C" to pin "C."
3. All other wiring (except shielded wiring) may be of #22 size.
4. 280 V. Mod., connecting pin "F" to pin "T", and 290 V. Trans., connecting pin "L" to pin "S", should be shielded and have 600 volt insulation between the shield and the center conductor.
5. All connections of accessories and junctions should be made inside the connectors to the proper pins, taking care to make good solder joints that will not cause short circuits to adjacent pins.

2. PRIMARY POWER CIRCUIT CONSIDERATIONS

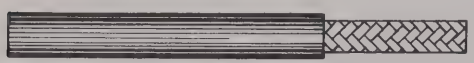
In addition to the fuses installed in the power unit, an acceptable aircraft circuit protector should be installed in the primary power source. Primary power drain information is provided in Section I.

3. AUDIO OUTPUT

Up to five watts of audio power output is available at an impedance of three ohms for loudspeaker operation, and three hundred ohms for two sets of six hundred ohm headphones.

4. ACCESSORY UNITS

If accessory items, such as a VOA-3A Omni-Converter or LFR-3 Low Frequency Receiver, are to be used with the MARK V, provision should be made when wiring the power cable to power these accessories. A systems cabling diagram is shown in Figure 8, with only the accessory wiring indicated. Reference must be made to both wiring diagrams for a complete installation. The same care must be taken to wire the accessory cables, in order to obtain trouble free operation.

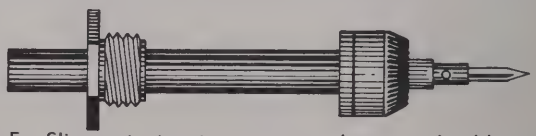


1. Trim cable jacket 19/64" for RG-58A/U.

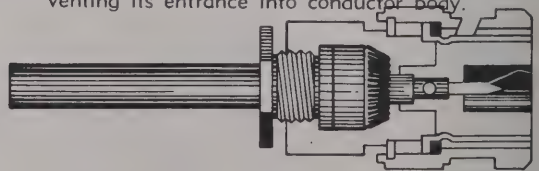
2. Fray shield and strip inner dielectric 1/8". Tin center conductor.

3. Taper braid and slide nut, washer, gasket and clamp over braid. Clamp should be squarely against cable jacket.

4. Comb out braid, fold back over clamp and trim as sho



5. Slip contact onto center conductor and solder, taking not to swell dielectric with excessive heat, thereby venting its entrance into conductor body.



6. Push this assembly into the body as far as it will go. H ing the cable and shell rigid, tighten the nut into b using the proper wrench.

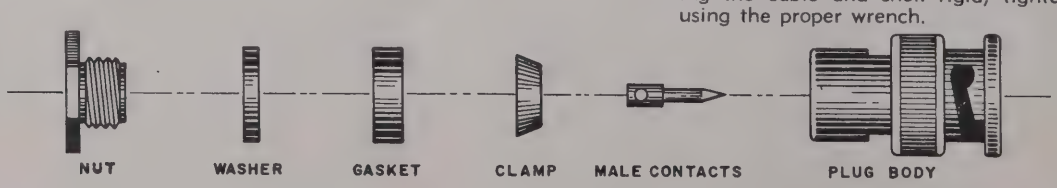


Figure 6. BNC CONNECTOR ASSEMBLY

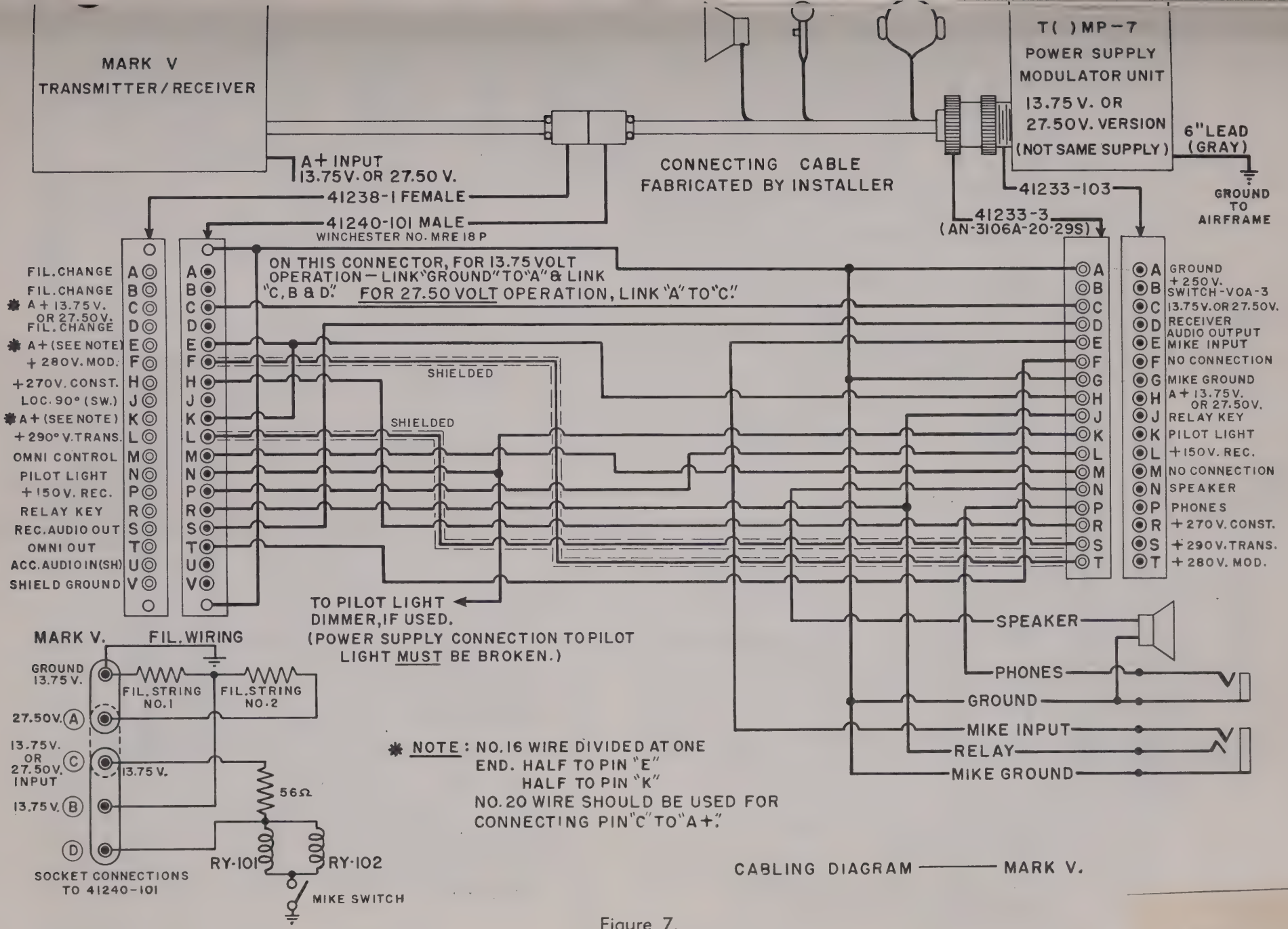

MARK V
TRANSMITTER/RECEIVER
T( )MP-7
POWER SUPPLY
MODULATOR UNIT
13.75 V. OR
27.50V. VERSION
(NOT SAME SUPPLY)
6" LEAD
(GRAY)
GROUND
TO
AIRFRAME
A+ INPUT
13.75V. OR 27.50 V.
41238-1 FEMALE
41240-101 MALE
WINCHESTER NO. MRE 18 P
CONNECTING CABLE
FABRICATED BY INSTALLER
41233-103
41233-3
(AN-3106A-20-29S)
ON THIS CONNECTOR, FOR 13.75 VOLT OPERATION — LINK "GROUND" TO "A" & LINK "C, B & D." FOR 27.50 VOLT OPERATION, LINK "A" TO "C."
SHIELDED
SHIELDED
FIL. CHANGE A
FIL. CHANGE B
* A+ 13.75 V. OR 27.50 V. FIL. CHANGE C
FIL. CHANGE D
* A+ (SEE NOTE) E
+ 280 V. MOD. F
+270 V. CONST. H
LOC. 90° (SW.) J
* A+ (SEE NOTE) K
+290° V. TRANS. L
OMNI CONTROL M
PILOT LIGHT N
+150 V. REC. P
RELAY KEY R
REC. AUDIO OUT S
OMNI OUT T
ACC. AUDIO IN (SH) U
SHIELD GROUND V
A GROUND
B +250 V. SWITCH-VOA-3
C 13.75 V. OR 27.50 V.
D RECEIVER AUDIO OUTPUT
E MIKE INPUT
F NO CONNECTION
G MIKE GROUND
H A+ 13.75 V. OR 27.50 V.
J RELAY KEY
K PILOT LIGHT
L +150 V. REC.
M NO CONNECTION
N SPEAKER
P PHONES
R +270 V. CONST.
S +290 V. TRANS.
T +280 V. MOD.
TO PILOT LIGHT DIMMER, IF USED.
(POWER SUPPLY CONNECTION TO PILOT LIGHT MUST BE BROKEN.)
SPEAKER
PHONES
GROUND
MIKE INPUT
RELAY
MIKE GROUND
MARK V. FIL. WIRING
GROUND 13.75 V.
FIL. STRING NO. 1
FIL. STRING NO. 2
27.50V. (A)
13.75V. OR 27.50V. INPUT (C)
13.75 V.
56Ω
13.75 V. (B)
(D)
RY-101
RY-102
MIKE SWITCH
SOCKET CONNECTIONS TO 41240-101
* NOTE: NO. 16 WIRE DIVIDED AT ONE END. HALF TO PIN "E" HALF TO PIN "K"
NO. 20 WIRE SHOULD BE USED FOR CONNECTING PIN "C" TO "A+."
CABLING DIAGRAM — MARK V.

Figure 7.

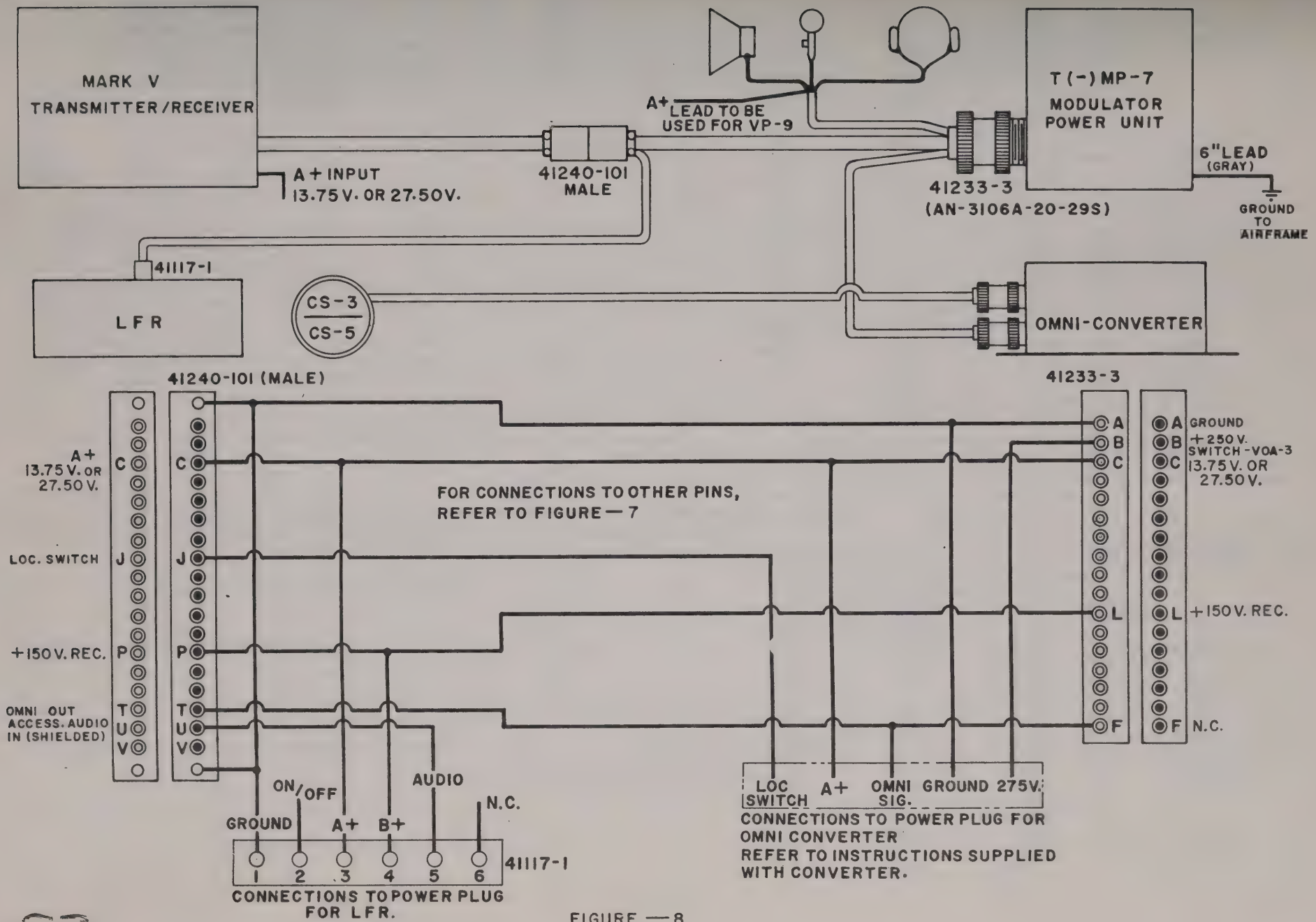

MARK V
TRANSMITTER/RECEIVER
A+ INPUT
13.75 V. OR 27.50 V.
41240-101
MALE
A+ LEAD TO BE
USED FOR VP-9
T(-)MP-7
MODULATOR
POWER UNIT
41233-3
(AN-3106A-20-29S)
6" LEAD
(GRAY)
GROUND
TO
AIRFRAME
41117-1
LFR
CS-3
CS-5
OMNI-CONVERTER
41240-101 (MALE)
41233-3
A+
13.75 V. OR
27.50 V.
LOC. SWITCH
+150 V. REC.
OMNI OUT
ACCESS. AUDIO
IN (SHIELDED)
FOR CONNECTIONS TO OTHER PINS,
REFER TO FIGURE — 7
GROUND
+250 V.
SWITCH-VOA-3
13.75 V. OR
27.50 V.
+150 V. REC.
N.C.
GROUND
ON/OFF
A+
B+
AUDIO
N.C.
1 2 3 4 5 6
41117-1
CONNECTIONS TO POWER PLUG
FOR LFR.
LOC SWITCH
A+
OMNI SIG.
GROUND
275V.
CONNECTIONS TO POWER PLUG FOR
OMNI CONVERTER
REFER TO INSTRUCTIONS SUPPLIED
WITH CONVERTER.

FIGURE — 8

SECTION III

THEORY OF OPERATION

A. RECEIVER

A crystal-controlled, double-conversion superheterodyne circuit is employed in the receiver section of the Mark V. The desired RF signal enters the receiver at the antenna connection and is separated from other signals by the first of three RF tuned circuits. These circuits are tuned in steps of one megacycle with the use of gang-switched, printed-circuit inductance wafers. A high gain 6DK6 pentode is used to amplify this RF signal, which then passes through a capacitively-coupled, double-tuned resonant network to the grid of the first mixer, V-102.

A high frequency IF of 25.9 mc is produced by selecting the difference frequency between the incoming signal and the injected voltage from the HF oscillator, V-103. The injection voltage is the fundamental frequency of this crystal-controlled, grounded-grid oscillator. Fifth overtone crystals are used, covering a frequency range of 82.55 to 100.55 mc., in one megacycle steps. The IF signal passes through a stage of HF IF amplification, with a fixed-tuned band-pass of one megacycle, 25.40 to 26.40 mc. From V-104, the signal goes to V-105, the second converter, where the cathode injected signal from the LF oscillator mixes with the HF IF signal to produce a low frequency IF of 7.0 mc. A triode oscillator, V-106, operating on the fundamental frequency and using third overtone crystals, 32.45 to 33.35 mc., is used for low frequency injection, to select the tenth megacycle steps in any given mc. The output of the second mixer is then passed through three stages of LF IF amplification, involving V-107, V-108, V-109, and eight resonant circuits.

One section of V-110 is used as a high-level diode detector; omni output is taken directly from the diode load. The compound peak noise limiter and the audio volume control are located between the detector and the audio output. The noise limiter comprises two diodes arranged to utilize both series and shunt-type peak limiting in a circuit in which the clipping levels compensate for variations in carrier strengths.

A delayed AVC is developed by a second diode section in V-110, and applied to the RF and IF stages, with the exception of the second converter and the last IF stage. The time constant of this AVC is controlled by the channel selector; for its accurate omni-range bearings, VOR channels require an AVC with a longer time constant than is wanted for communication. A DC amplifier stage in V-110, controlled by AVC action, actuates the squelch audio section of V-112. This squelch section is biased to cut off audio signals, until the signal level rises higher than the noise level setting of the squelch control. A cathode follower audio output, V112B, is used to transform the high-impedance signals to the low-impedance required by the transistorized audio amplifier.

B. TRANSMITTER

Ninety crystal-controlled transmitter channels are provided by the Mark V, using the sum frequency of the two common oscillators for the output.

V-103, a 12AT7, is used as a crystal-controlled, grounded-grid HF oscillator. Employing fifth overtone crystals and operating on the fundamental oscillator frequencies, 85.55 to 93.55 mc., steps of one megacycle, switched by S-206 and 207, provide the basic frequencies, 118 to 126 mc. Similarly, the low frequency oscillator, V-106, is a crystal-controlled triode, using third overtone crystals and operating on the fundamental oscillator frequencies, 32.45 to 33.35 mc. The tenth megacycle steps are provided by this oscillator, controlled by S-208.

The injection voltages from these two oscillators are fed to V-201, the 6CB6 mixer, using screen grid injection of the HFO signal, and control grid injection of the LFO signal. Selected by the plate output tank circuit, the sum frequency of the two signals is coupled to the first buffer-amplifier stage, V-202. The amplified signal is applied to the grid of the second buffer, V-203, where it is further amplified and used to drive the final stage.

A 5686 beam power pentode is used as a final amplifier, delivering approximately five watts of RF carrier output through a band-pass filter to the antenna.

High-level plate modulation is applied to the final amplifier by the T(-)MP-7 Transistorized Modulator-Power Unit.

C. TRANSISTOR MODULATOR-POWER SUPPLY

The T(-)MP-7 power supply utilizes one of the most recent designs in power converters. The conventional vibrator or dynamotor has been replaced with power transistors. With no moving elements to be damaged by vibration and mechanical shock, the transistor has tremendous advantage over the conventional supply. Efficiency has also increased; the transistorized supply is from 20 to 40% more efficient than the vibrator or dynamotor.

The power supply section of the T(-)MP-7 uses two power transistors, Q-401 and 402, and a toroid power transformer, T-401, in a circuit whose simplified operation is as follows: The instant A-plus is applied, because of the inevitable dissimilarity of the two transistors, more current will begin to flow through one than the other. This greater flow of current through one half of the primary winding will induce a current in the bias winding so polarized as to bias the conducting unit into greater conduction and hold the non-conducting unit at cut-off. Almost instantly, the transformer core reaches saturation, i.e., the transformer can pass

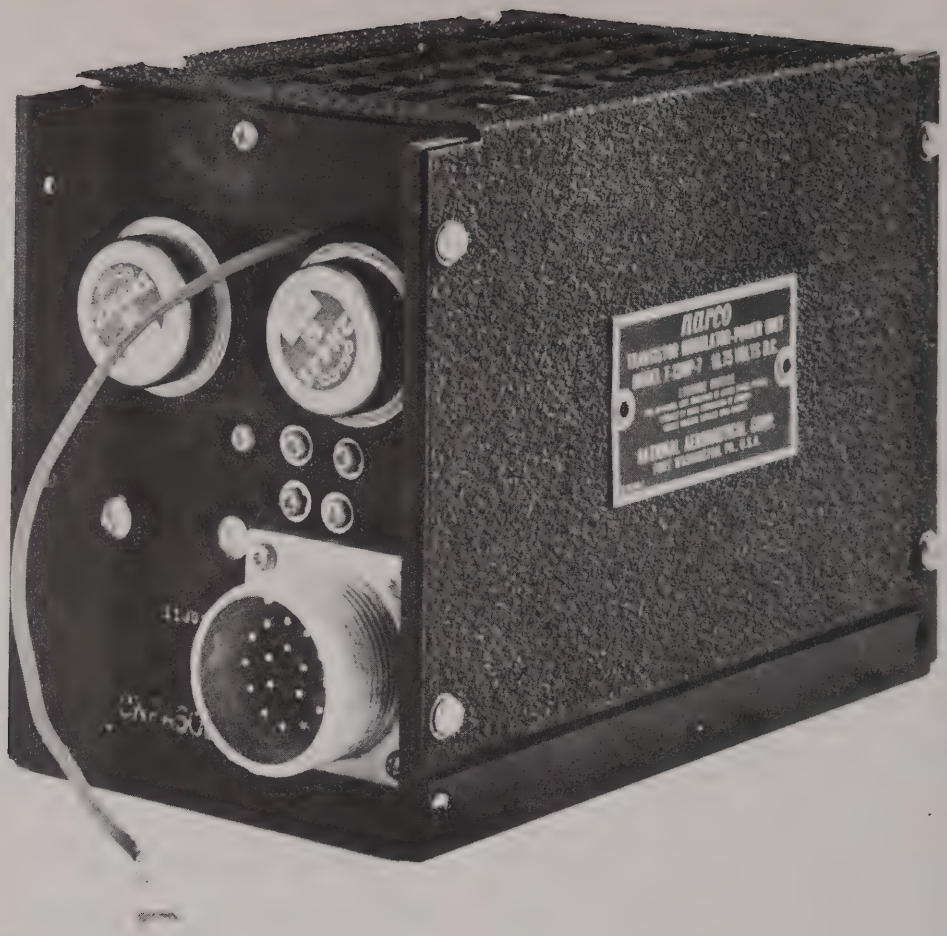


Figure 9.

no greater amount of current, and reaches maximum flux density. Since there are no longer any moving lines of force, no voltage is induced in the bias winding, and the current through the conducting transistor starts to decrease. As the current in one half of the primary winding decreases, the induced voltage in the bias winding reverses polarity, causing the second transistor to conduct. Capacitors C-403 and C-404 in the base voltage divider network store energy, which, at the conclusion of each half cycle is used to switch the oscillator, since the high-nickel core materials used in the transformer do not provide the necessary inductive "kick" needed to switch from one half cycle to the next. This switching action repeats at a very high speed, and the output of T-401 is essentially a clean square wave with a repitition rate of approximately 1500 cycles. Rectification is accomplished with the use of four silicon diodes, CR-401, 402, 403, and 404. LC filtering is performed easily and efficiently, due to the high cyclic rate of the oscillatory output of the supply; clean hum-free DC output, without the spikes that produce RF interference, is provided for the operation of the transmitter and receiver. The audio section of the T(-)MP-7, including transistors Q-301, 302, 303, and associated components, provides amplification for either the receiver output or the microphone. The transmit-receive relay, K-401, connects the base of the input transistor, Q-301, to either the receiver or the microphone output. Q-301 is a Class A current amplifier, which functions as a driver for the Class B output amplifier stage. The audio output transformer, T-302, is equipped with two secondary windings, one tapped winding to operate the speaker or headsets, and the other for modulating the transmitter.

The audio section includes the "mike gain" control, R-301, located on the lower corner of the audio transistor mounting plate, and the "mod. adj." slider resistor, R-308, located under the chassis. R-301 is used to compensate for differences in aircraft cabin noise and modulation characteristics of microphones. R-308, the "mod adj" resistor, limits the maximum power output of the Class B stage to approximately 7.5 watts, to prevent overmodulation of the transmitter output. From 6 to 14 db of speech clipping is provided by the system, depending upon the type of microphone used and the setting of R-301. Using a T-17 microphone and with R-301 set fully on, six db of speech clipping is provided, while a microphone with a higher output, such as an Electro-Voice, Model 205, used in a quiet airplane, can give up to 14 db of clipping. This degree of speech clipping, which raises the level of the consonant sounds in the speech, increases the "voice power" of the transmitted signal four or five times.

SECTION IV

MAINTENANCE

A. MAINTENANCE PROCEDURES (Mechanical)

1. Access to shielded sections of the front end is accomplished by removing the two shields on top and one on the bottom of the set. The positions of the components in these shielded sections are critical and should not be altered or disturbed in any way, unless it is absolutely necessary.

2. **Replacement of Defective Crystals.**

   1. Any crystal, 82.55 to 85.55 mc. and 92.55 to 100.55 mc., can be removed by unsoldering the leads and pulling it out of the assembly. Insert the replacement crystal in its proper slot (refer to Figure 10), re-solder, taking care to replace any damaged insulation.
   2. The crystals from 86.55 to 89.55 mc. can be replaced if the adjacent vertical shield (held in by **three** screws) is removed. Replacement is then accomplished as in Step 1.

3. **Shaft Alignment for Channel Selectors. (Figure 10)**

   1. Receiver—

      a. Set receiver detent in any position, and dial at 108.0 mc. Tighten set screws on gear 1, mounted on detent shaft shown in section A-A with setscrews oriented as shown.

      b. Align 1/4" receiver crystal shaft and switch shaft as shown in section B-B, and tighten gear 2. Rotate dial to 126.0 mc. and further adjust gear 2 so that the gears run smoothly and switch rotor tabs make proper contact with the clips at the 126 and 108.0 mc dial positions, i.e., the rotor tab position should be equalized with respect to the centerline of the clips at the extreme dial positions.

      c. Crystal-bank wafers should be adjusted, if necessary, by means of their mounting screws, to provide free running shafts and gears.

      d. Tighten set screws on gear 2 and align receiver switch rotors (section B-B) with dial at 108 mc.; tighten gear 3 with set screws and set receiver shaft 1 and rotor tab positions as shown in section B-B. Tighten gear clamp 1 and rotate dial to 126.0 mc. Adjust gear clamp 1 so that the gears run smoothly. The rotor position should be equalized relative to the centerline of the clips at the extreme positions of the dial (108. and 126. mc).

      e. Gear backlash can be adjusted by shifting receiver switch wafer locations, utilizing attaching screws, 10 and 11.

   2. Transmitter—

      a. Set transmitter mc detent in fully CCW position, and dial at 118. mc. Tighten small gear on detent shaft with set screws as shown in section C-C. Align the 3/8" transmitter crystal shaft so that rotor tab and shaft position correspond to that shown in section D.D. Lightly tighten gear 4 (set screws positioned as in section C-C) and rotate dial to 126 mc. Adjust gear so that rotor tab position relative to the centerline of the clips at the extreme dial positions (118 to 126 mc.) is equalized. Then tighten gear 4 shown in section C-C.

      b. To adjust transmitter shaft, first set the dial at 118 mc. Align transmitter rotors and shaft as shown in Section D-D. Tighten gear 5 to transmitter shaft and lightly tighten gear 6 (section D-D). Rotate dial to 126mc. and adjust switch wafers, using their mounting bolts, so the gears run smoothly and with minimum backlash. Adjust gear 6 to equalize the rotor tab position relative to the centerline of the clips, at the extreme dial positions. Tighten gear 6.

B. TROUBLE-SHOOTING PROCEDURES

The following data is provided as an aid to isolation of trouble, should it develop. Care should be taken to avoid moving or changing lead dress when trouble-shooting.

1. Receiver Trouble-Shooting Chart

NOTE: After isolating the trouble, reference to alignment procedure will provide additional information.

Signal Generator is modulated 30% at 1000 cps.

Volume control and squelch control should be set fully clockwise.

Step	Test	Test Signal	Test Point	Normal Indication	Probable Cause of Abnormal Indication
1	Overall check	VHF Sig. Gen. 1.8 uv., set on receiver channel, input at antenna terminal.	Audio wattmeter at speaker	1.6 watt output; AVC actuates at 6-9 uv.	Proceed to following steps.
2	Pre-detector	Sig. Gen. 6uv., set on rec. channel.	AC VTVM on detector side of R-127	2 volts AC. Proceed to step 8.	Proceed to step 3.
3	Low Freq. I.F.	VHF Signal Generator 200 uv., 7 Mc. Pin 1, V-107	AC VTVM on detector side of R-127	0.12 VAC	Failure of V-105, 107, 108 or 109; defective component in LF IF
4	Low Freq. Osc. & LF Converter Gain	Receiver set .00-.90 Signal Gen. set 200 uv., 27.05-27.95 Mc. Pin 1, V-105	AC VTVM on detector side of R-127	0.2 VAC (2-1 variation from .9 to .0)	Failure of V-106; defective component in Low Freq. Osc. stage
5	High Freq. I.F.	Receiver set .00-.90 Signal Gen. set 5 uv., 27.05-27.95 Mc. Pin 1, V-102	AC VTVM on detector side of R-127	0.5 VAC	Failure of V-102, 104; defective component in HF I.F. stages
6	High Freq. Osc. High Freq. Conversion Gain	Receiver set to 108.5-126.5 Mc. Signal Generator set 20 uv., 108.5 - 126.5 Mc Pin 1, V-102	AC VTVM on detector side of R-127	0.5 VAC	Failure of V-103; defective component in High Freq. Osc.
7	R.F. Amplifier	Receiver set to 108.5 - 126.5 Mc. Signal Generator set 5 uv., 108.5 - 126.5 Mc. Rec. Ant. Conn.	AC VTVM on detector side of R-127	2 VAC	Failure of V-101; defective component in R.F. Amplifier stage
8	Receiver Audio Section	Sig. Gen. on Rec. channel; Volume and squelch open. 2 volts AC at detector (R-127)	AC VTVM on Pin 8 of V-112-B	0.4 VAC	Follow normal audio trouble-shooting procedures

C. ALIGNMENT PROCEDURES

1. EQUIPMENT REQUIRED

Transmitter—

a. RF wattmeter and 50 ohm dummy load (Bird Model 61 or equivalent).

b. VTVM (RCA Voltohmyst or equivalent).

c. Carbon microphone.

Receiver—

a. AC VTVM (Ballantine Model 300 or equivalent).

b. Low frequency signal generator (General Radio Model 1001A or equivalent).

c. High frequency signal generator (Hewlett-Packard Model 608D or equivalent).

d. Sweep generator (Kay Vari-Sweep or equivalent).

e. High input impedance VTVM (RCA Voltohmyst or equivalent).

f. Oscilloscope (Dumont Model 401 or equivalent).

g. High input impedance detector (specially constructed; refer to Figure 12).

i. Audio wattmeter (General Radio Type 583-A or equivalent).

j. Headphones, low impedance (600 ohms).

General—

a. Variable primary power source (Electro Model NF or equivalent).

2. RECEIVER ALIGNMENT

Low Frequency IF Stages

1. Connect the AC VTVM to the detector side of R-127.
2. Connect the vertical input of the oscilloscope to the same point to monitor the output. Set the horizontal sweep to INTERNAL.
3. Disconnect pin 1 of V-105 from T-102, leaving R-111 in the grid circuit.
4. Connect the low frequency signal generator (set to 7 mc) to pin 1 of V-105.
5. Tune the low frequency IF transformers, T-103, 104, 105 and 106 for maximum AC voltage. 10 uv. input should give approximately 0.12 VAC output.

Low Frequency Oscillator

1. Set receiver KC dial to .00 position.
   Set transmitter KC dial to .90 position.
2. Connect VTVM on R-164 and use the negative 15 volt scale.
3. Connect the wattmeter to transmitter output on the rear of the chassis.
4. Key the transmitter and tune L-115 for maximum negative voltage. Voltage indications should range from approximately —5 VDC in .00 position of receiver KC dial to —14 VDC in the .90 position.

Low Frequency IF Conversion Gain

1. Connect the AC VTVM to the detector side of R-127.
2. Connect the high frequency signal generator (set to the 25-27mc. range, 200uv. output) to pin 1 of V-105.
3. Set the receiver KC dial to .90 position.
4. Set signal generator to 26.35 mc. Record indication from AC VTVM; this should be betweeen .5 and .8 VAC.
5. Set the receiver KC dial to the .00 position.
6. Set the signal generator to 25.45 mc. Record indication from AC VTVM; this should be between .2 and .4 VAC.
7. The calculated difference should be 6db or better between the .00 and the .90 indications.

High Frequency IF Stage

1. Disconnect pin 5 of V-105 from T-103, and install the high input impedance detector (refer to Figure 12) as follows:

   Connect 470 ohm resistor from B-plus side of T-103 to pin 5 of V-105.
   Connect 4.7 mmfd capacitor from detector to pin 5 of V-105.
   Connect the output of the detector to "Y" input of the oscilloscope.
   Connect the AC VTVM to the "Y" input of the scope.
   Ground detector to receiver chassis.
   Connect A-plus to pin 5 of V-112.

2. Set scope horizontal sweep to "EXTERNAL."
3. Connect the sweep output of sweep generator (sweep frequency— 25.90 mc.) to the "X" input of the scope.
4. Disconnect L-125 from pin 1 of V-102, leaving R-104 in the circuit.
5. Connect RF output of sweep generator to pin 1 of V-102.
6. Tune the high frequency IF transformers, T-101 and 102, for the response in Figure 13. Loop couple signal from high frequency signal generator to pin 1 of V-102 in order to position the 25.45 and 26.35 mc peaks.
7. A 2:1 ratio (6 db) should exist between the 25.45 and 26.35 mc peaks.

High Frequency Oscillator Tuning

1. Connect a 10K ohm isolation resistor to pin 2 of V-103.

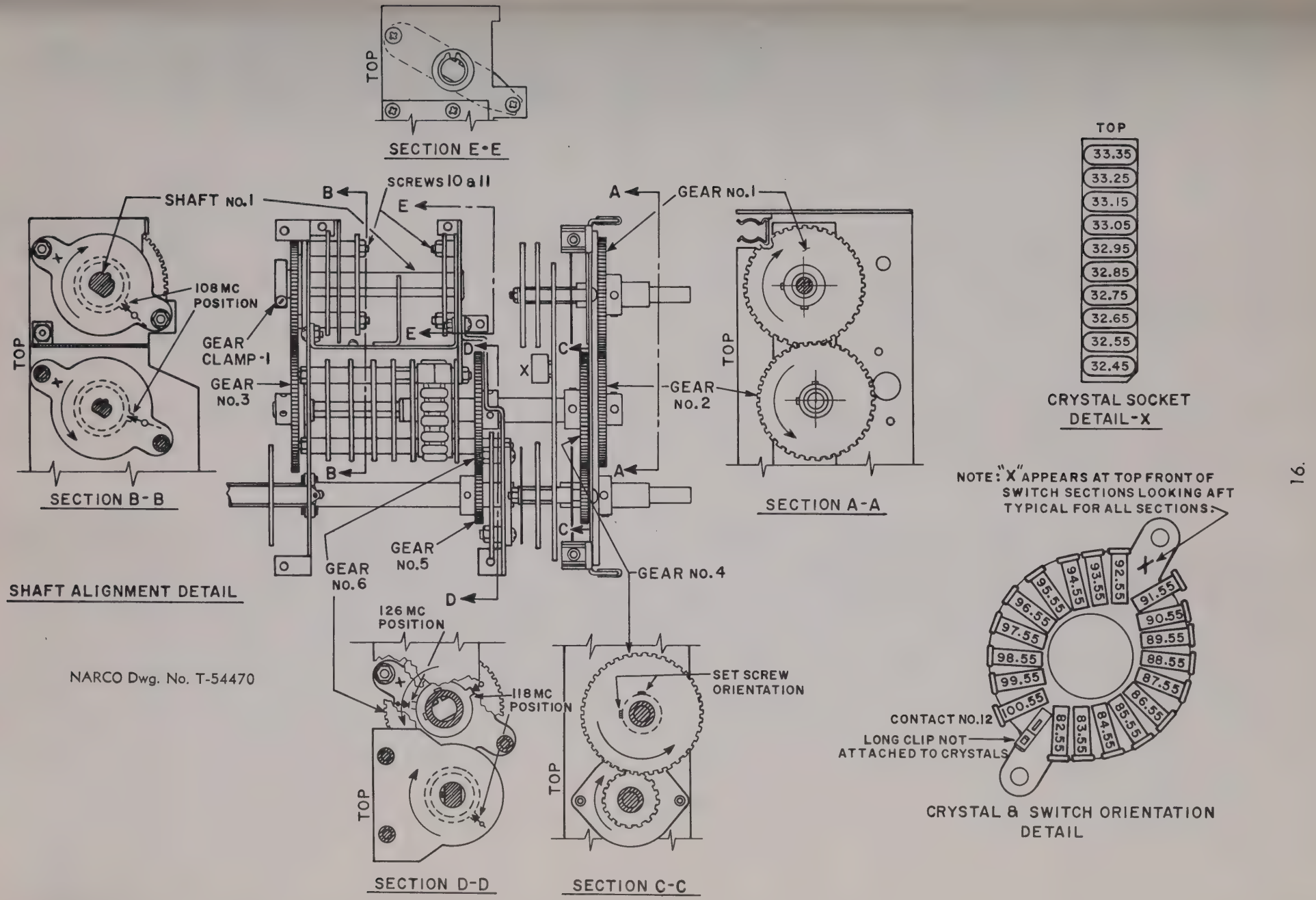

TOP
SECTION E-E
SHAFT NO.1
SCREWS 10 & 11
B
E
108 MC POSITION
GEAR CLAMP-1
GEAR NO.3
D
X
C
A
GEAR NO.1
GEAR NO.2
TOP
SECTION B-B
SECTION A-A
SHAFT ALIGNMENT DETAIL
GEAR NO.6
GEAR NO.5
GEAR NO.4
126 MC POSITION
118 MC POSITION
SET SCREW ORIENTATION
SECTION D-D
SECTION C-C
NARCO Dwg. No. T-54470
TOP
33.35
33.25
33.15
33.05
32.95
32.85
32.75
32.65
32.55
32.45
CRYSTAL SOCKET DETAIL-X
NOTE: "X" APPEARS AT TOP FRONT OF SWITCH SECTIONS LOOKING AFT TYPICAL FOR ALL SECTIONS.
92.55
93.55
94.55
95.55
96.55
97.55
98.55
99.55
100.55
91.55
90.55
89.55
88.55
87.55
86.55
85.55
84.55
83.55
82.55
CONTACT NO.12
LONG CLIP NOT ATTACHED TO CRYSTALS
CRYSTAL & SWITCH ORIENTATION DETAIL

Figure 10.

2. Connect VTVM, set on positive 50 volt range, to the isolation resistor.
3. Set receiver MC dial to 126 position. Tune L-114 for minimum positive voltage.
4. Set receiver MC dial to 108 position. Tune C-150 for minimum positive voltage.
5. Repeat steps 4 and 5 until no further decrease in voltage can be noted.

   Note: When not oscillating, 20 VDC can be observed at pin 2 of V-103; when oscillating, approximately 12 to 16 VDC can be observed at pin 2.

High Frequency IF Conversion Gain

1. Connect AC VTVM to the detector side of R-127.
2. Disconnect pin 1 of V-102 at L-125, leaving R-104 in the circuit.
3. Connect the HF signal generator, using 5uv. output in the 25 to 26 mc range, to pin 1 of V-102.
4. Set receiver KC dial to .00 position and tune the signal generator to 25.45 mc. Record indication of the AC VTVM.
5. Set receiver KC dial to .90 position and tune signal generator to 26.35 mc. Record indication of AC VTVM.
6. The .00 indication and the .90 indication should be approximately equal. (Between .6 and .8 VAC, with the .50 position no more than 6 db down).

Receiver RF Alignment

1. Connect AC VTVM on the detector side of R-127.
2. Set HF signal generator on 108 to 126 mc range, and connect the RF output to the receiver input. Use 10 uv. input.
3. Set receiver MC dial to the 126 position and KC dial to .50 position. Set signal generator to 126.50 mc.
4. Tune L-111, 112, and 113 for maximum AC VTVM indication.
5. Set receiver MC dial to 108 position and KC dial to.50 position. Set signal generator to 108.50 mc.
6. Tune C-102, 106, 108 for maximum AC VTVM indication.
7. Repeat steps 3, 4, 5, and 6 until no further increase in AC voltage can be obtained.
8. A level of 2 VAC should be obtained with an input of 5 to 10 uv. input across the band (108.0 to 126.9 mc.).

TRANSMITTER ALIGNMENT

Should it become necessary to re-align the VHF transmitter, the following alignment procedure must be observed, in the order indicated.

1. Connect an RF wattmeter and 50 ohm load to the transmitter antenna connector. Apply proper DC voltage to the equipment.
2. With the KC selector on .90 position, connect VTVM probe on the existing 1 megohm isolating resistor (this can be done by inserting the probe through the rubber grommet on the side of the chassis so that it makes contact with the binding post on which th resistor is mounted) on grid of LFO, pin 6 of V-106, with VTVM set on negative 15 volt range. Tune L-115 (LFO tank) for maximum reading. Check other positions, .9 to .0, to be sure all crystals are oscillating.
3. Using a 10K ohm resistor for isolation, connect the VTVM probe on the grid of the High Frequency Oscillator, Pin 7 of V-103, with the VTVM on the positive 50 volt range. Channel to 126 Mc and tune L-211 for minimum voltage. Channel to 118 Mc and tune C-205 for minimum. Repeat this operation several times, tuning L-211 at 126 Mc and C-205 at 118 Mc, until no further reduction in voltage is possible.
4. Set the VTVM to the negative 15 volt range, and connect the probe to the grid resistor (33K) of V-202, the First Buffer. Channel to 126.4 Mc and tune L-212 for maximum negative voltage. Channel to 118.4 Mc and tune C-213 for maximum voltage. Repeat this operation several times until no further increase in voltage is obtainable.
5. With the VTVM on the negative 50 volt range, connect the probe to the grid side of R-211 (12K), the Second Buffer (V-203) grid resistor. Channel to 126.4 Mc and tune L-213 for maximum negative voltage. Channel to 118.4 Mc and tune C-220 for maximum. Repeat these adjustments until no further increase in voltage is obtainable.
6. Connect the VTVM, set on the negative 150 volt range, on the grid side of R-214 (22K), the Final Amplifier grid resistor. Channel to 126.4 Mc. and tune L-214 for maximum voltage drive to the final; channel to 118.4 Mc and tune C-223 for maximum voltage. Repeat these adjustments for optimum tracking.
7. Channel to 118.4 Mc and tune C-230 for maximum power output, as indicated on the RF wattmeter. Channel to 126.4 Mc and tune L-215 for maximum power output. (Note: L-215 is tuned by changing the spacing between the turns of the 4-turn final tank coil). Repeat these two adjustments for maximum power output across the band.
8. **Final Check:**

   With the VTVM connected as in step 6, channel to 126.4 Mc and adjust L-212, L-213, and L-214 for maximum drive to the final. Channel to 118.5 Mc and adjust

C-213, C-220, and C-223 for maximum drive to the final amplifier. This drive should be at least 70 volts (negative) on all channels.

NOTE: The RF filter network on the output of the transmitter has been tuned at the factory. Adjustment of this filter is not part of transmitter alignment, and should not be attempted in the field.

D. POWER SUPPLY - MODULATOR UNIT

Since the T(-)MP-7 Power Supply—Modulator is a completely transistorized unit employing some of the most recent developments in power converters and audio circuitry, the following information is supplied to aid the service agency when testing or trouble-shooting the unit.

ADJUSTMENTS—

1. R-301—Normally set "full on" in the maximum clockwise position, unless high level aircraft cabin noise and a sensitive microphone causes the transmitted carrier to be modulated excessively. If this happens, the control should be turned counter-clockwise until the noise level does not interfere with normal speech.

WARNING

Transistors can be damaged or ruined if subjected to excessive voltage or current. Therefore, avoid the application of surges or high DC input to the T(-)MP-7, such as the no-load voltage from an unregulated DC bench power supply. Also avoid short-circuiting of primary, secondary or B-plus circuits to the chassis, or to adjacent terminals, while the unit is operating. Such excessive current or voltage may result in a condition known as "punch through," where the germanium barrier in the transistor shorts. Such failures may not occur at the moment of shorting, but at some later time. NOTE: Do not operate the T(-)MP-7 in an aircraft while the aircraft electrical system is connected to an auxiliary power unit.

TEST EQUIPMENT SET-UP

When servicing the T(-)MP-7, care must be taken to avoid damaging or shorting the transistors used in the power supply and modulator.

BENCH POWER SUPPLY

DC Power Units operating from the 115 volt AC line will require a suitable load resistor on the DC output terminals to improve the regulation and prevent voltage surges. The value and wattage rating of the resistor required for use with a particular supply will depend on the maximum current rating of the supply. A resistor of 3 ohms, 300 watts, connected across the DC source will draw 4.6 amperes at 13.75 volts, or 9.2 amperes at 27.5 volts; this should be sufficient constant load to provide good voltage regulation. We suggest connecting three 1-ohm, 100 watt resistors in series across the DC output terminals of the bench power source.

CHECKING POWER TRANSISTORS

Power transistors of the types used in the T(-)MP-7 may be checked for "shorted" condition with an ohmmeter. Using a Simpson Model 260 ohmmeter, on the "R x 1" scale, place the negative lead of the meter on the collector (stud) and the positive lead on the emitter (yellow lead). A "good" transistor will measure 200-500 ohms, or more, depending on its condition and the characteristics of the ohmmeter used.
Shorted transistors will measure 2 ohms, or less.

CHANGING TRANSISTORS

The transistors used in the power supply section (Q-401, 402) have their stud and case (collector) grounded to the heat sink on which they are mounted. Note, however, that the transistors in the audio circuit (Q-301, 302, 303) are insulated from the heat sink by thin pieces of mica sheet. It these transistors are to be changed, care must be taken to replace the mica insulation. Check with an ohmmeter between transistor case and ground to be sure the collectors are insulated from ground. When operating the unit, do not short the cases of these transistors to the chassis.

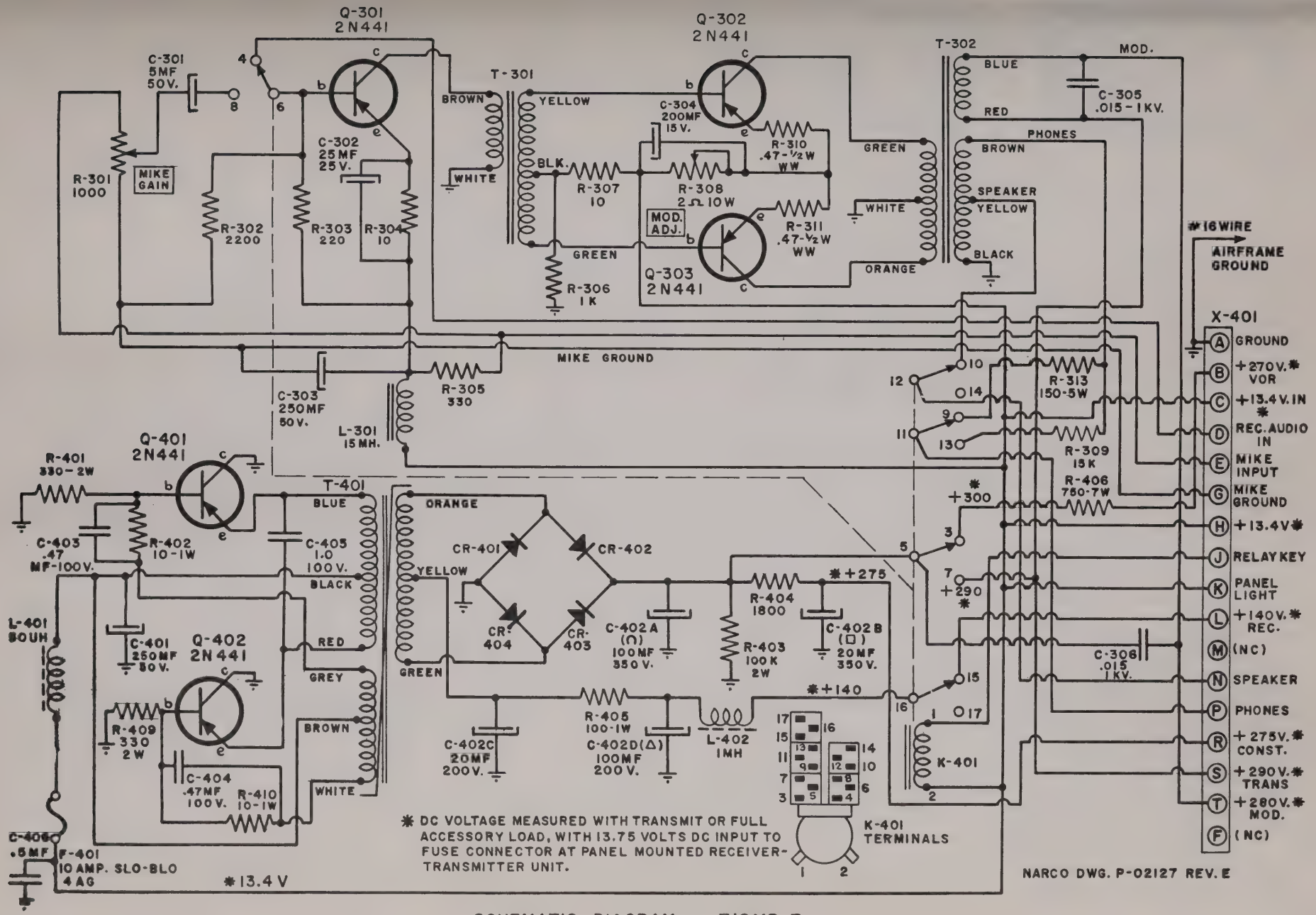
CHECKING AUDIO AMPLIFIER

The audio amplifier in the T(-)MP-7 may be checked for operation by applying an audio signal to pin "D" of X-401. An audio voltage of approximately 0.1 volts, RMS, applied at this point should produce 4-5 watts audio output from the 3 ohm speaker winding.

POWER SUPPLY VOLTAGE READINGS

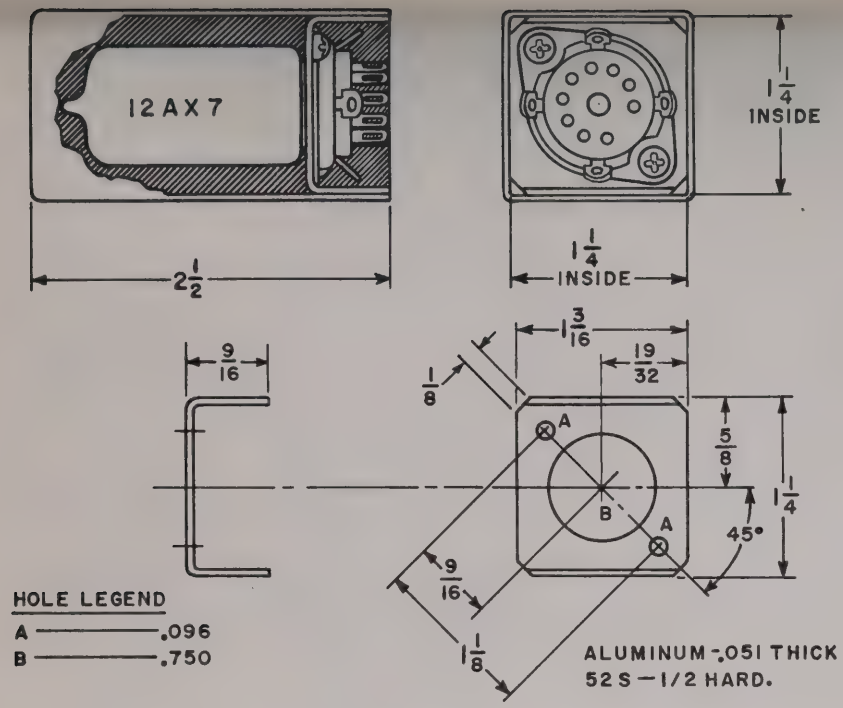
With the VHF transmitter-receiver unit connected to the T(-)MP-7, and with proper DC voltage applied, the following voltage readings should be measured at X-401:

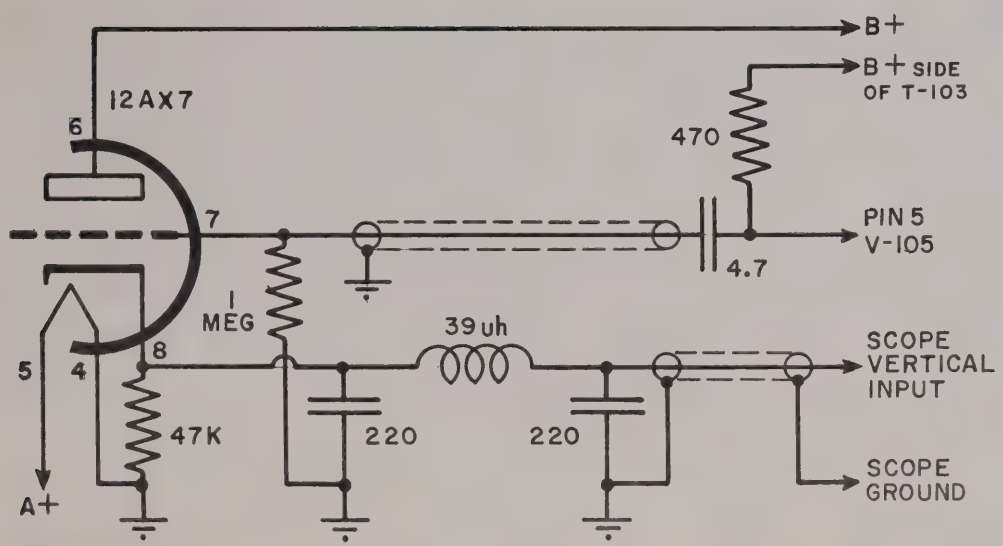
Pin	Function	
	Receive	Transmit
B	250. VDC ±10V	———
C	13.4 or 27.35 VDC	13.4 or 27.35 VDC
H	13.4 or 27.35 VDC	13.4 or 27.35 VDC
K	13.4 VDC	13.4 VDC
L	140 VDC ±10V	———
R	275 VDC ±10V	275 VDC ±10V
S	———	290 VDC ±10V
T	———	280 VDC ±10V



SCHEMATIC DIAGRAM — T12MP-7
CHASSIS CNPA 50-B

Figure 11.


12AX7
2½
1¼ INSIDE
1¼ INSIDE
9/16
1 3/16
19/32
1/8
5/8
1¼
45°
A
B
A
9/16
1⅛
HOLE LEGEND
A .096
B .750
ALUMINUM -.051 THICK
52S — 1/2 HARD.


B+
B+ SIDE OF T-103
12AX7
6
470
7
PIN 5 V-105
4.7
1 MEG
39 uh
5
4
8
SCOPE VERTICAL INPUT
47K
220
220
SCOPE GROUND
A+

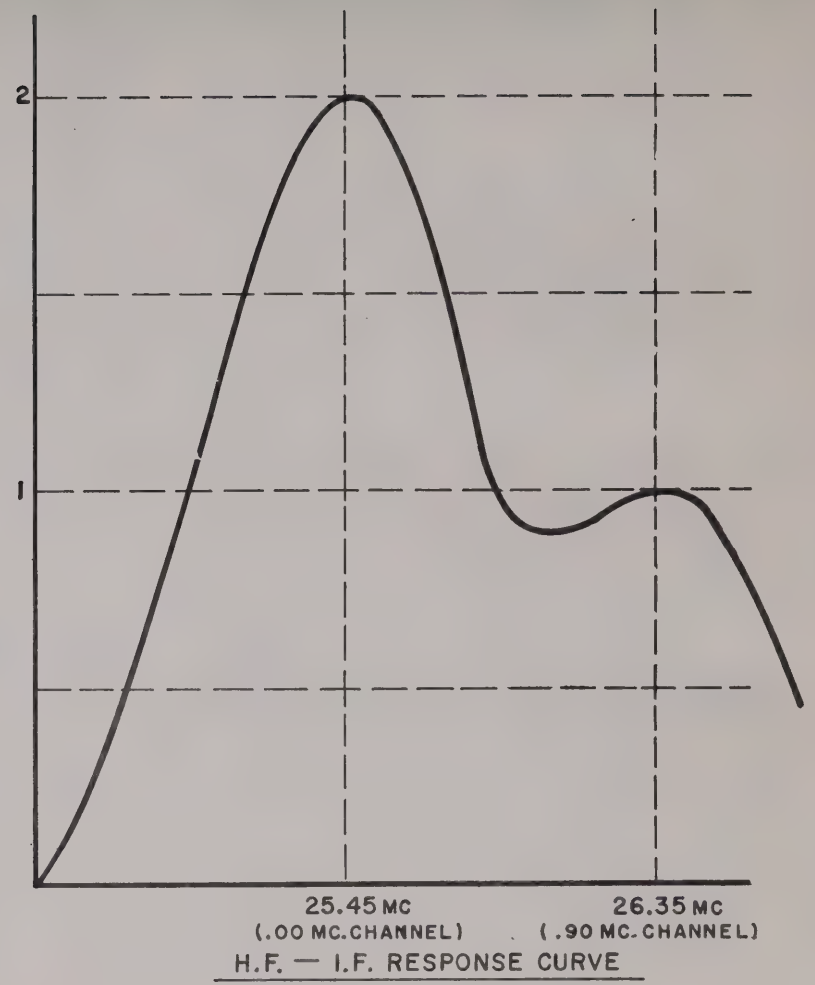
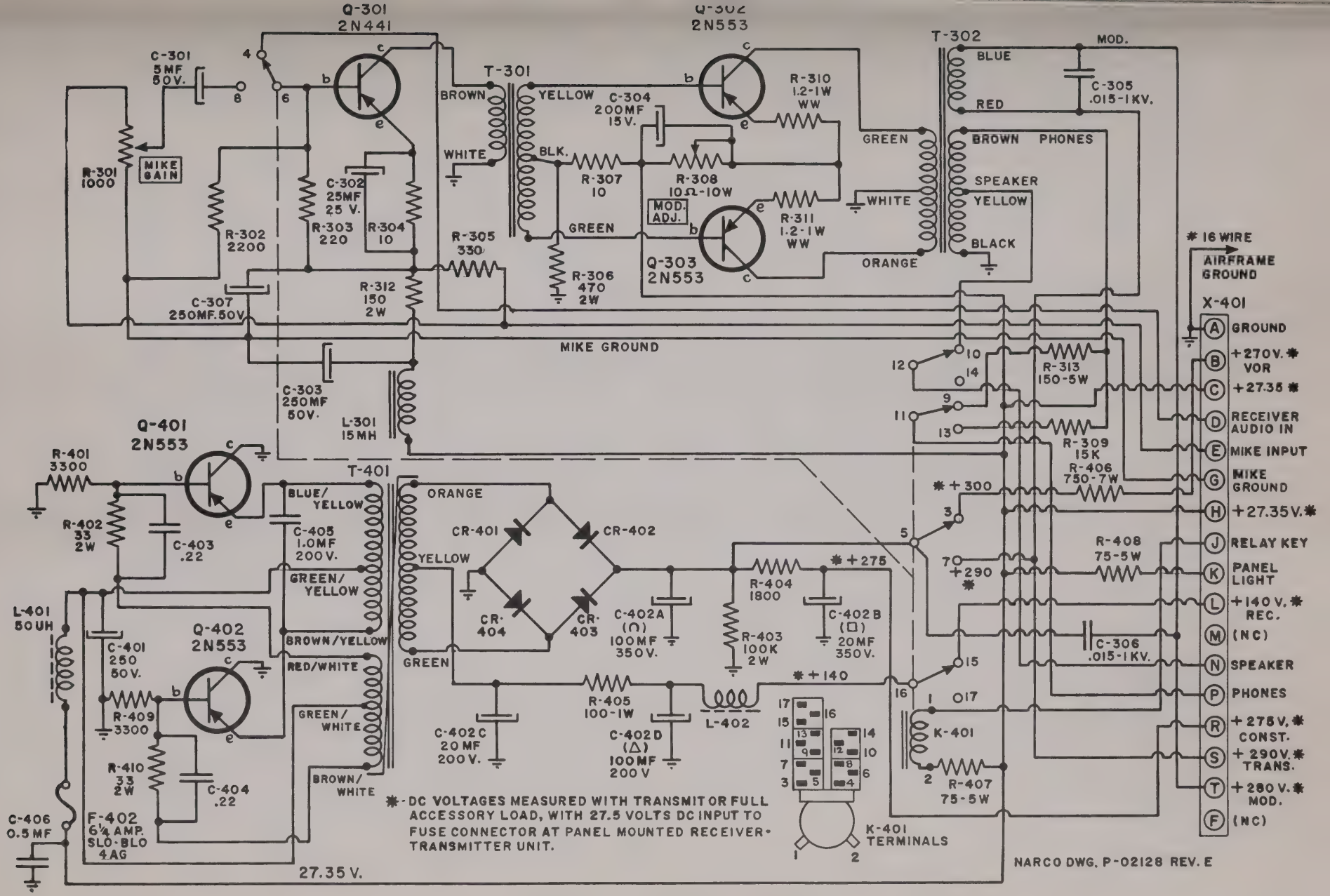

2
1
25.45 MC
(.00 MC. CHANNEL)
26.35 MC
(.90 MC. CHANNEL)
H.F. — I.F. RESPONSE CURVE

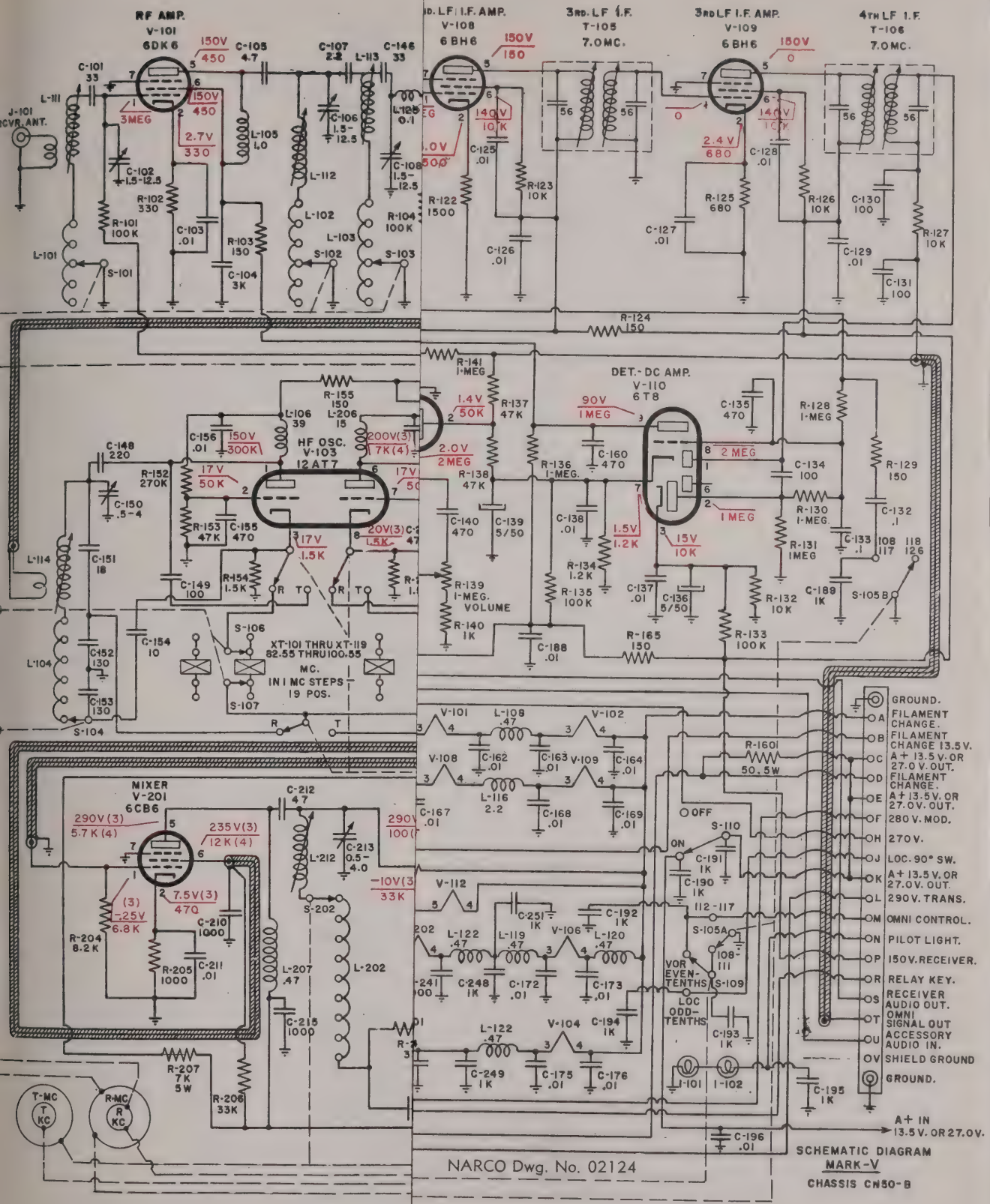
Figure 12.



SCHEMATIC DIAGRAM — T24MP-7

CHASSIS CNPB50-B

Figure 13.

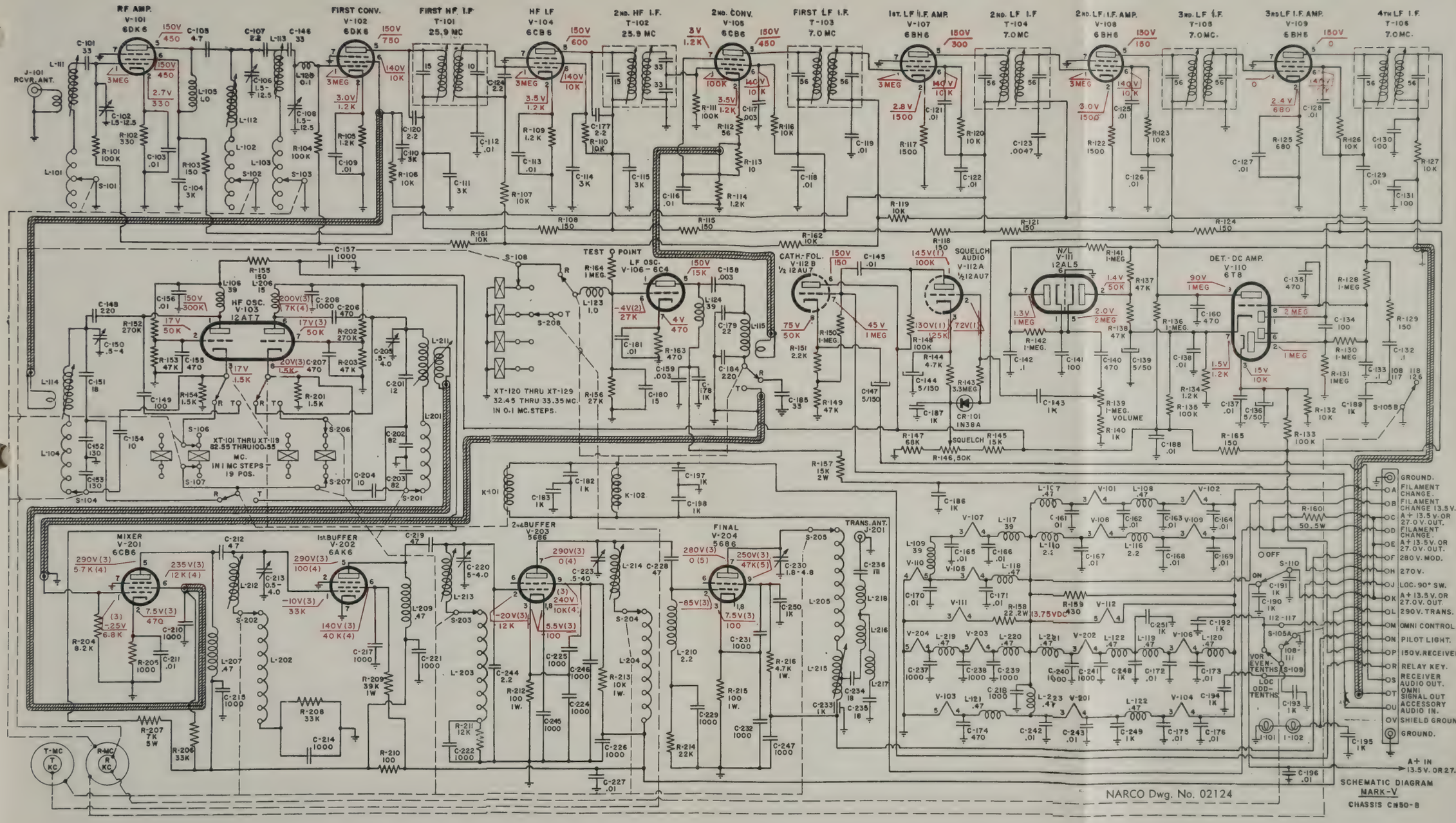


VOLTAGES ABOVE LINE AND RESISTANCES BE ED, VOLTAGE WILL INCREASE.

ALL DC VOLTAGES MEASURED TO GROUND, E S FROM −3V. TO −8V., .00 TO .90 POSITION.

VOLUME CONTROL AND SQUELCH CONTROL FU KEY DOWN, MEASURED THRU .47uh. BLOCKING CHOKE.

ALL RESISTANCES MEASURED TO GROUND, WIT



VOLTAGES ABOVE LINE AND RESISTANCES BELOW LINE, SHOWN IN RED.

ALL DC VOLTAGES MEASURED TO GROUND, EXCEPT WHERE NOTED, WITH A HIGH IMPEDANCE VOLTMETER AT 13.75 VOLTS INPUT.

VOLUME CONTROL AND SQUELCH CONTROL FULLY COUNTER CLOCKWISE, EXCEPT WHERE NOTED.

ALL RESISTANCES MEASURED TO GROUND, WITH CABLES DISCONNECTED, EXCEPT WHERE NOTED.

NOTES: 1. AS SQUELCH IS OPENED, VOLTAGE WILL INCREASE.
2. GRID VOLTAGE VARIES FROM −3V. TO −8V., .00 TO .90 POSITION.
3. TRANSMIT POSITION, KEY DOWN, MEASURED THRU .47uh. BLOCKING CHOKE.
4. MEASURED TO PIN "L".
5. MEASURED TO PIN "F".

SECTION V

REPLACEMENT PARTS

MBOL	PART No.	DESCRIPTION
07, 120, 124, 177, 244	21201-229	Capacitor, Ceramic, Tubular, 500V., NPO, 2.2 mmfd.
05	21201-479	" " " " " 4.7 "
54, 204	21201-100	" " " " " 10. "
01	21203-759	" " " " N150 7.5 "
80	21201-150	" " " " NPO 15. "
51	21203-180	" " " " N150 18. "
79	21201-220	" " " " NPO 22. "
04, 146, 185	21201-330	" " " " NPO 33. "
212, 219, 228	24507-35	" Fixed, Glass, 10%, 500V., 47. "
202, 203	21121-820	" Silver Mica, 5%, 500 V., 82. "
130, 131, 134, 141, 149	21308-101	" Ceramic, Tubular, " 100. "
152, 153	21121-131	" Silver Mica, 5%, " 130 "
148, 184	21308-221	" Ceramic, Tubular, " 220. "
135, 140, 155, 160, 174, 206, 207	21291-2	" " Disk, 470. "
143, 157, 178, 182, 183, 186, 187, 189-195, 197, 198, 208, 210, 214, 215, 217, 218, 221, 222, 224, 226, 229, 231, 232, 237, 238, 239, 240, 241, 245, 246, 248, 249, 250	24506-10	" " " 1000. "
247	21291-12	" A.B., 1000V., 1000. "
123	23065-109	" Fixed, Mylar, .0047 mfd.
104, 110, 111, 114, 115, 117, 158, 159	21291-4	" Ceramic, Disk .003 "
101, 103, 113, 121, 125, 127, 128, 161-173, 175, 176, 181, 211, 242, 243	21291-5	" " " .01 "
116, 118, 122, 126, 129, 137, 138, 145, 156, 188, 196, 227	21291-6	" " " .01 "
112, 119	23065-113	" Fixed, Mylar, .01 "
132, 133, 142	23064-25	" " " .1 "
136, 139	21524-49	" " Electrolytic, 50V., 5 "
144, 147	21524-35	" " " 150V., .5 "
234, 236	24504-25	" Porcelain, 18 mmfd.
230	22027-1	" Air Variable, 1.8-4.0 "
233	24505-1	" Ceramic, Feed-thru, 1000 "
102, 106, 108	22019-2	" Variable Plunger type 1.5-12.5 "
150, 205, 213, 220, 223	22023-3	" Trimmer, Glass 0.5-4.0 "
235 (L-127)	24524-25	" Porcelain, (with integral coil), 18 "
R-101	75008-1	Crystal Diode, 1N388
101, 102		Lamp, panel, GE No. 51, red
101		Connector, Antenna, Receiver
201		" " Transmitter
101	65126-10	Relay, 3PDT
102	65129-1	Relay, miniature, DPDT
125	11138-20	Choke, R.F., 0.1 microhenry
107, 108, 118 to 122, 208, 219 to 223, 207	11138-5	Choke, 0.47 microhenry
105, 123	11138-7	Choke, 1.0 microhenry
110, 116, 210	11138-9	Choke, 2.2 microhenry
206	11138-19	Choke, 15 microhenry
106, 109, 117, 124	11359-20	Choke, 39 microhenry
111	11412-11	Coil, RF grid
112	11412-12	Coil, RF plate
113	11412-13	Coil, converter grid
114	11412-14	Coil, HF oscillator, receiver
115	11273-4	Coil, LF oscillator
211	11412-16	Coil, HF oscillator, transmitter
212	11273-1	Coil, locked oscillator grid
213	11273-2	Coil, buffer grid

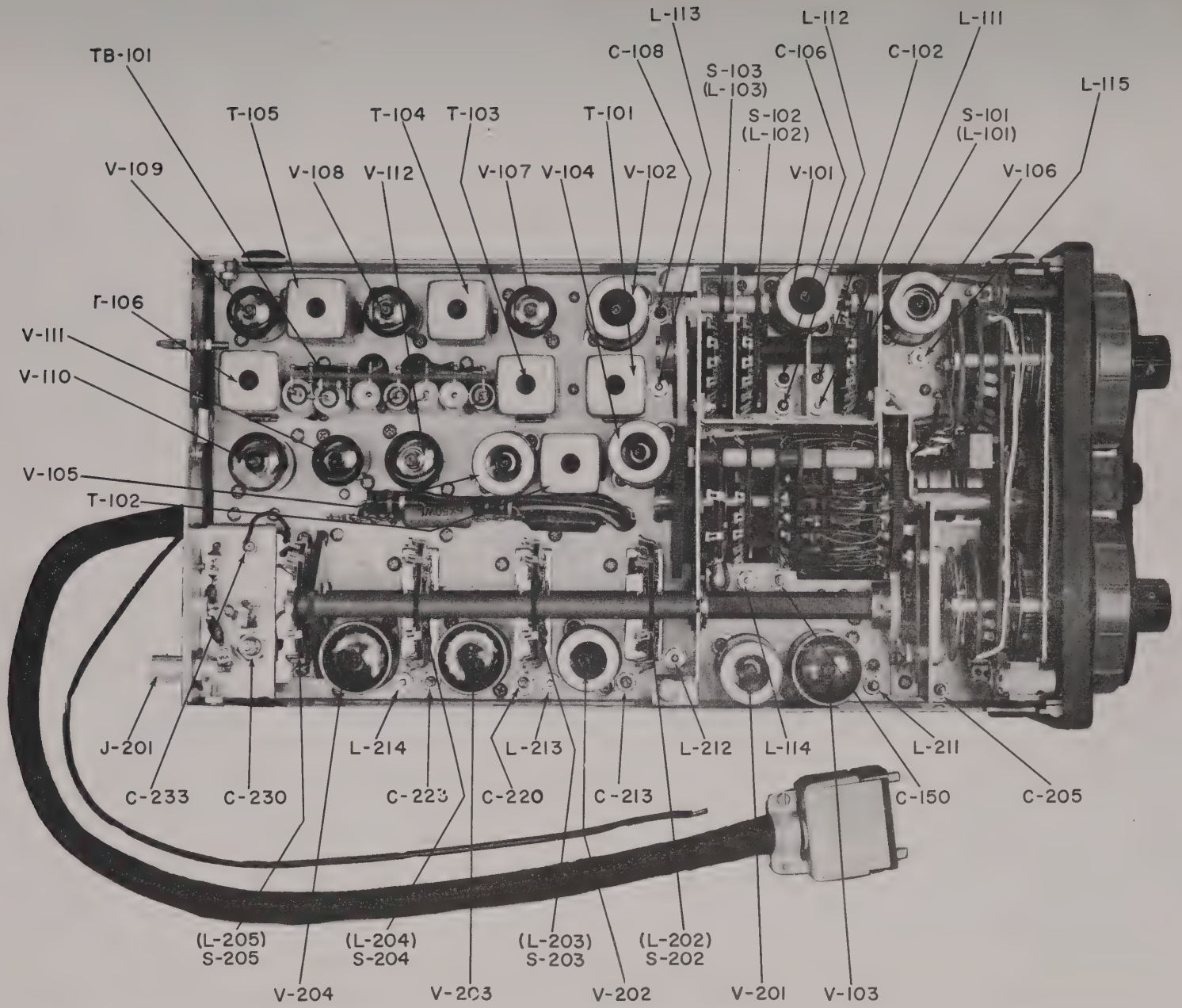

TB-101
T-105
T-104
T-103
T-101
L-113
L-112
L-111
C-108
C-106
C-102
S-103
(L-103)
S-102
(L-102)
S-101
(L-101)
L-115
V-109
V-108
V-112
V-107
V-104
V-102
V-101
V-106
T-106
V-111
V-110
V-105
T-102
J-201
L-214
L-213
L-212
L-114
L-211
C-233
C-230
C-223
C-220
C-213
C-150
C-205
(L-205)
S-205
(L-204)
S-204
(L-203)
S-203
(L-202)
S-202
V-204
V-203
V-202
V-201
V-103

Figure 15.

SYMBOL	PART No.	DESCRIPTION
L-214	11273-3	Coil, buffer plate
L-215	11274-1	Coil, air final
L-216, 218	11416-1	Coil, RF filter
L-217		Coil, RF filter: part of C-235
R-113	31141-100	Resistor, Carbon, ±10%, 1/2 watt, 10 ohms
R-112	31141-560	" " " " 56 "
R-103, 108, 118		
R-103, 108, 118, 121, 124, 129, 155, 115	31110-151	150 "
R-102	31110-331	" " " " 330 "
R-163	31110-471	" " " " 470 "
R-125	31110-681	" " " " 680 "
R-140, 205	31110-102	" " " " 1000 "
R-105, 109, 114	31141-122	" " " " 1200 "
R-154, 201, 117, 122	31141-152	" " " " 1500 "
R-151	31110-222	" " " " 2200 "
R-204	31110-822	" " " " 8200 "
R-107, 110, 116, 119, 120, 123, 126, 161, 162, 106,	31110-103	" " " " 10K "
R-211	31110-123	" " " " 12K "
R-145	31110-153	" " " " 15K "
R-214	31110-223	" " " " 22K "
R-156	31110-273	" " " " 27K "
R-137, 138, 149, 153, 203 148	31110-473	" " " " 47K "
R-208, 206	31110-333	" " " " 33K "
R-147	31110-683	Resistor, Carbon, ±10%, 1/2 watt, 68K ohms
R-101, 104, 111, 133, 135	31110-104	" " " " 100K "
R-152, 202	31110-274	" " " " 270K "
R-130, 131, 136, 141, 142, 150, 164	31110-105	" " " " 1 Megohm
R-143	31110-335	" " " " 3.3 "
R-212, 215, 210	31135-101	" " " " 100 ohms
R-159	31135-431	" " " " 430 "
R-216	31135-472	" " " " 4700 "
R-213	31135-103	" " " " 10K "
R-209	31135-393	" " " " 39K "
R-158	31113-220	" " " 2 " 22K "
R-157	31136-153	" " " " 15K "
R-160	31118-500	" Wire " 5 " 50 "
R-207	31162-5	" " ±5% 5 " 7000 "
R-139, 146	32028-1	Potentiometer, dual, with switch, 1 megohm and 50K ohms
S-101, 102, 103	61284-1	Switch, 20-position, step inductor (L-101, 102, 103)
S-104,	61285-1	Switch, 20-position, step inductor (L-104)
S-105	61283-1	" AVC, VOR/ILS
S-106, 107	61282-1	" 20-position, crystal selector
S-108, 208	61278-1	Switch, 20 position, crystal selector
S-109	61279-1	" " odd-even select
S-110		" power, part of R-139
S-201	61286-1	" step inductor (L-201)
S-202, 205	61294-102	" step inductor assembly (L-202, 205)
S-203, 204	61294-101	" " " " (L-203, 204)
S-206	61280-1	" crystal selector
S-207	61281-1	" " "
T-101	11269-1	Transformer. IF, 27.5 MC
T-102	11270-1	" " "
T-103, 104, 105	11207-1	" IF interstage, 7Mc.
T-106	11268-1	" IF output, 7 MC.

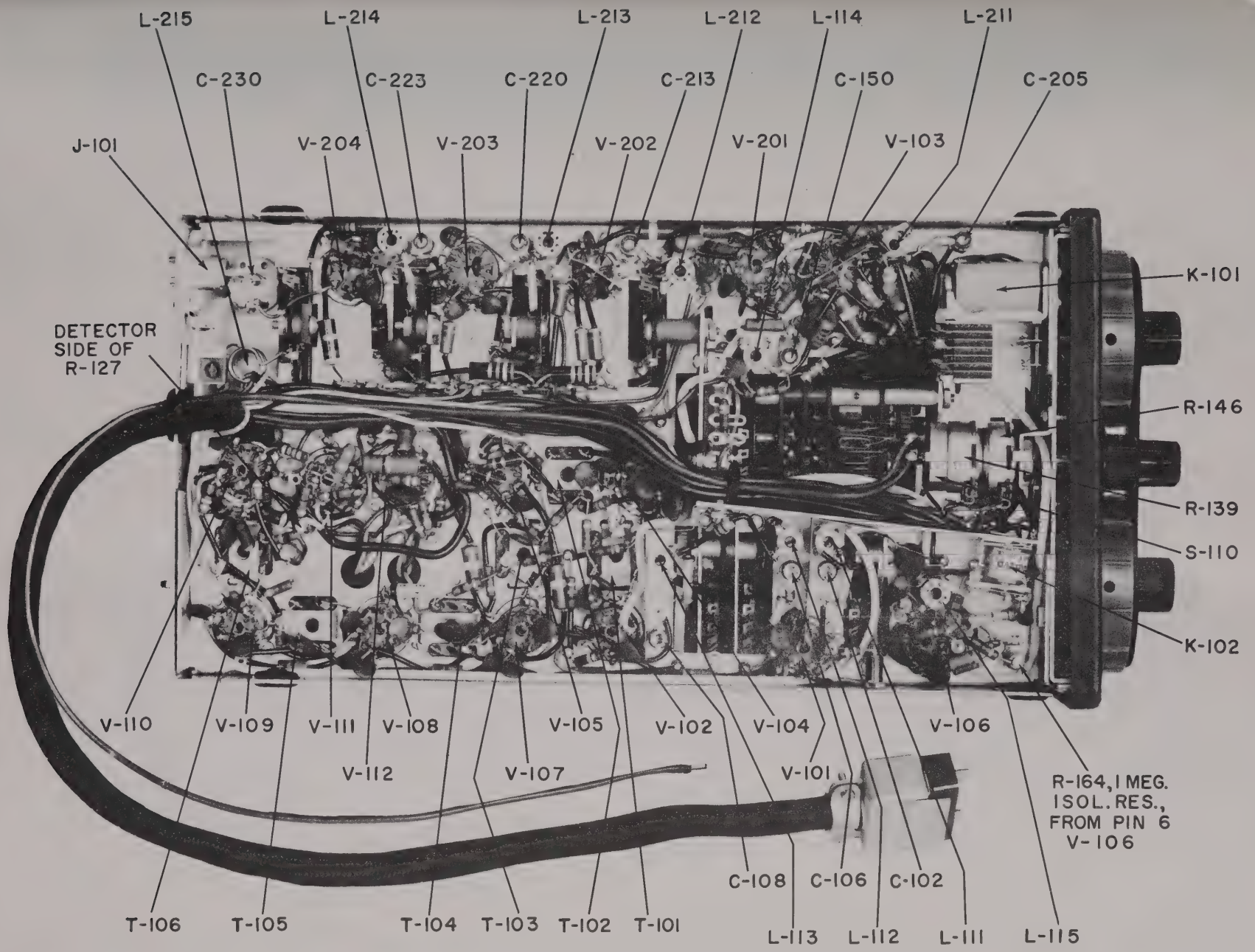

L-215
L-214
L-213
L-212
L-114
L-211
C-230
C-223
C-220
C-213
C-150
C-205
J-101
V-204
V-203
V-202
V-201
V-103
K-101
DETECTOR SIDE OF R-127
R-146
R-139
S-110
K-102
V-110
V-109
V-111
V-108
V-105
V-102
V-104
V-106
V-112
V-107
V-101
R-164, 1 MEG. ISOL. RES., FROM PIN 6 V-106
C-108
C-106
C-102
T-106
T-105
T-104
T-103
T-102
T-101
L-113
L-112
L-111
L-115

Figure 16.

SYMBOL	PART No.	DESCRIPTION	
XT-101 thru XT-119	72012-103	Crystal, Quartz, Wire-in, MC	Kit, 82.55-100.55 Mc.
XT-101	72007-75	" " " "	82.55 Mc. 108 Mc.
XT-102	72007-76	" " " "	83.55 Mc. 109 Mc.
XT-103	72007-77	" " " "	84.55 Mc. 110 Mc.
XT-104	72007-78	" " " "	85.55 Mc. 111 Mc.
XT-105	72007-79	" " " "	86.55 Mc. 112 Mc.
XT-106	72007-80	" " " "	87.55 Mc. 113 Mc.
XT-107	72007-81	" " " "	88.55 Mc. 114 Mc.
XT-108	72007-82	" " " "	89.55 Mc. 115 Mc.
XT-109	72007-83	" " " "	90.55 Mc. 116 Mc.
XT-110	72007-84	" " " "	91.55 Mc. 117 Mc.
XT-111	72007-85	" " " "	92.55 Mc. 118 Mc.
XT-112	72007-86	Crystal, Quartz, Wire-in,	93.55 Mc. 119 Mc.
XT-113	72007-87	" " " "	94.55 Mc. 120 Mc.
XT-114	72007-88	" " " "	95.55 Mc. 121 Mc.
XT-115	72007-89	" " " "	96.55 Mc. 122 Mc.
XT-116	72007-90	" " " "	97.55 Mc. 123 Mc.
XT-117	72007-91	" " " "	98.55 Mc. 124 Mc.
XT-118	72007-92	" " " "	99.55 Mc. 125 Mc.
XT-119	72007-93	" " " "	100.55 Mc. 126 Mc.
XT-120 thru XT-129	72012-104	Crystal, Quartz, Plug-in, KC	Kit, 32.45-33.35 Mc
XT-120	72006-170	Crystal, Quartz, Plug-in,	32.45 Mc. .00 Mc.
XT-121	72006-171	" " " "	32.55 Mc. .10 Mc.
XT-122	72006-172	" " " "	32.65 Mc. .20 Mc.
XT-123	72006-173	" " " "	32.75 Mc. .30 Mc.
XT-124	72006-174	" " " "	32.85 Mc. .40 Mc.
XT-125	72006-175	" " " "	32.95 Mc. .50 Mc.
XT-126	72006-176	" " " "	33.05 Mc. .60 Mc.
XT-127	72006-177	" " " "	33.15 Mc. .70 Mc.
XT-128	72006-178	" " " "	33.25 Mc. .80 Mc.
XT-129	72006-179	" " " "	33.35 Mc. .90 Mc.

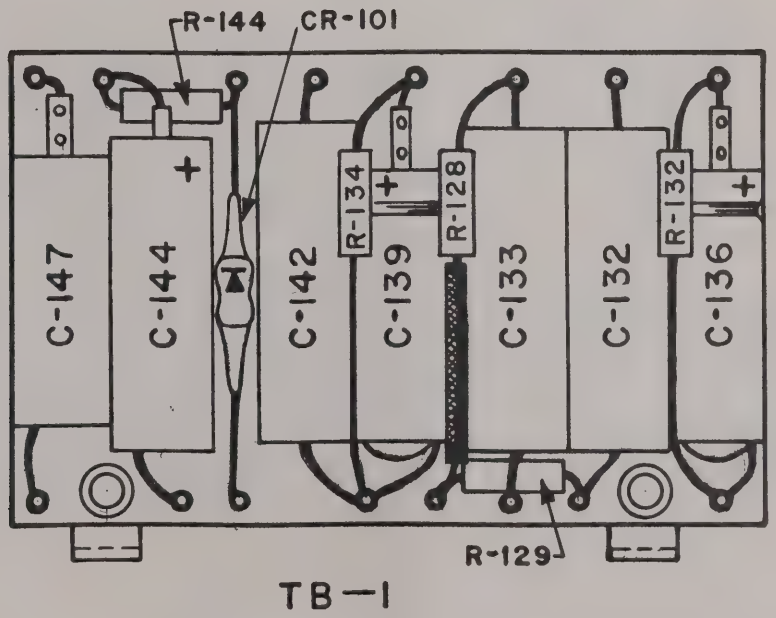


Figure 17.

SYMBOL	PART No.	DESCRIPTION
C-301	21524-20	Capacitor, electrolytic, 50 V., 5 Mfd.
C-302	21524-10	" " 25 V., 25 "
C-303, 307	21524-50	" " 50 V.,250 "
C-304	21524-44	" " 15 V.,200 "
C-305, 306	21189-153	" paper, 1000 V.,.015 "
C-401	21524-48	" electrolytic 50 V.,250 "
C-402	21525-14	" " 200 V., 20-100 "
C-403, 404		350 V., 20-100 "
(T12MP-7)	23065-83	" Mylar, ±10%, 100 V., .47 "
C-403, 404		
(T24MP-7)	23064-79	" " 100 V., .22 "
C-405		
(T12MP-7)	23065-187	" " ±10%, 100 V., 1 "
	23065-187	" " " 200 V., 1 "
C-406	21402-504	" metallized, 200 V., .5 "
CR-401, 402, 403, 404	75202-1	Rectifier, silicon
F-401		
(T12MP-7)	66504-12	Fuse, slow blow, 10 ampere, 4 AG
F-401		
(T24MP-7)	66504-10	" " " 6.25 " "
K-401	65126-5	Relay, 5 PDT
L-301	11215-3	Choke, filter, 15 millihenry
L-401	11176-3	" hash, 50 microhenry
L-402	11360-10	" encapsulated, 1 millihenry, 80 Ma.
Q-301	75504-1	Transistor, 2N441, DELCO
Q-302, 303		
(T-12MP-7)	75504-2	" matched pair, 2N441, DELCO
Q-302, 303		
(T-24MP-7)	75503-2	" " " 2N553, DELCO
Q-401, 402		
(T-12MP-7)	75504-1	" 2N441, DELCO
Q-401, 402		
(T-24MP-7)	75503-1	" 2N553, DELCO
R-301	32001-5	Resistor, variable, linear, 1000 ohms
R-302	31110-222	" carbon, 10%, 1/2 watt 2200 "
R-303	31110-221	" " " " " 220 "
R-304, 307	31141-100	" " " " " 10 "
R-305,	31110-331	" " " " " 330 "
R-306		
(T-12MP-7)	31110-102	" " " " " 1000 "
R-306		
(T-24MP-7)	31110-151	" " " " " 150 "
R-308		
(T12MP-7)	33002-209	" adjustable, wire, 10 watt, 2 "
R-308		
(T24MP-7)	33002-100	" " " " " 10 "
R-309	31110-153	" carbon, 10%, 1/2 watt 15K "

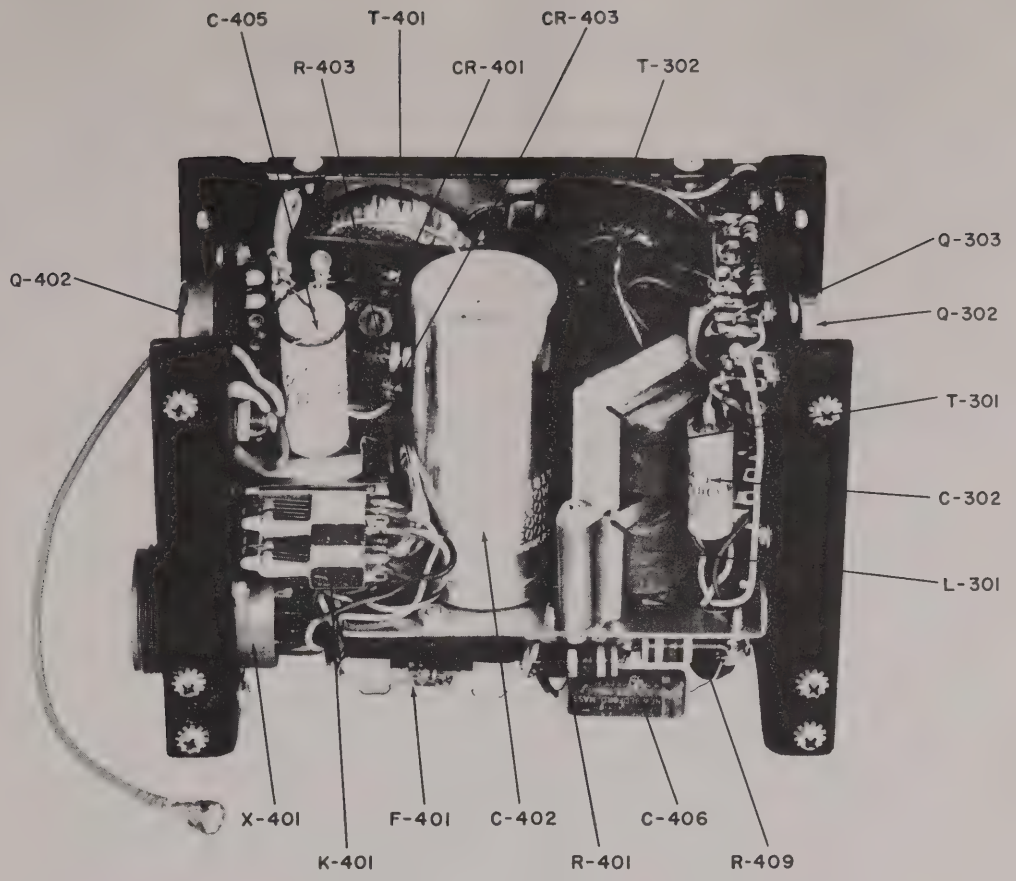


Figure 18.

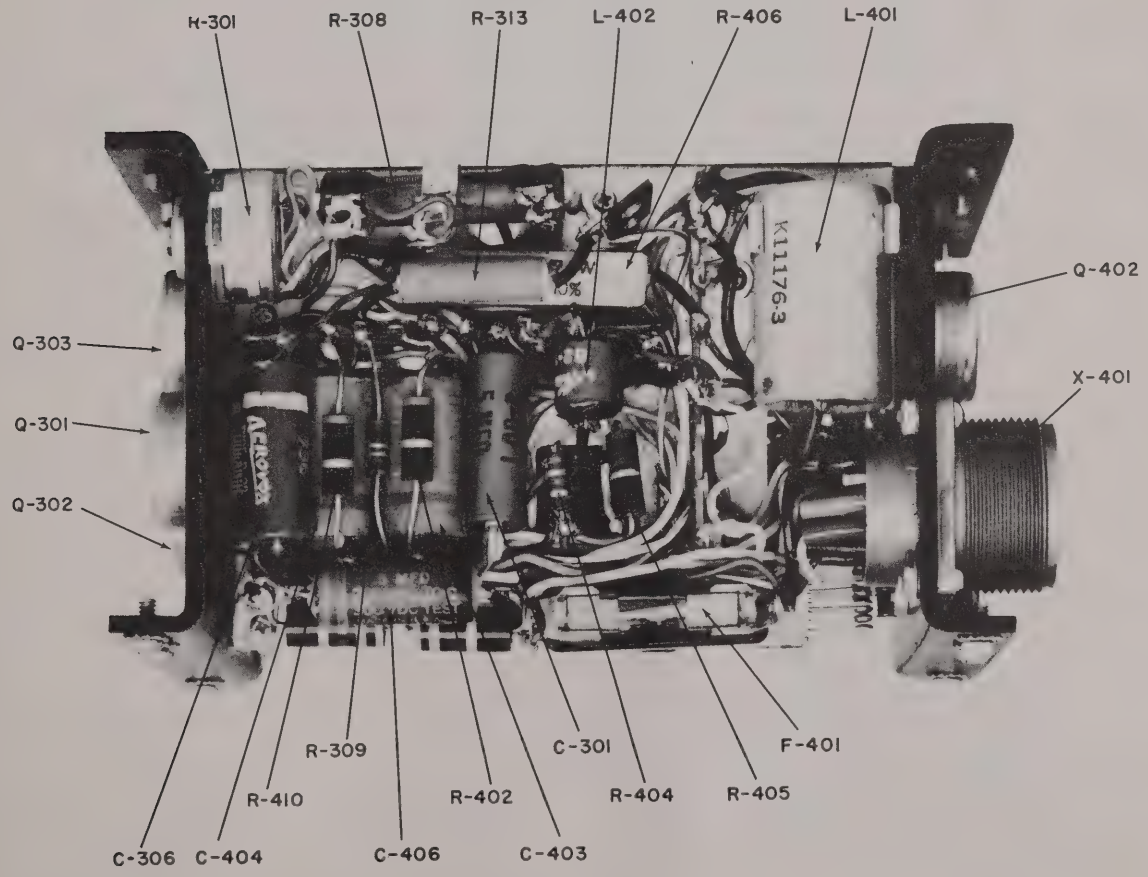
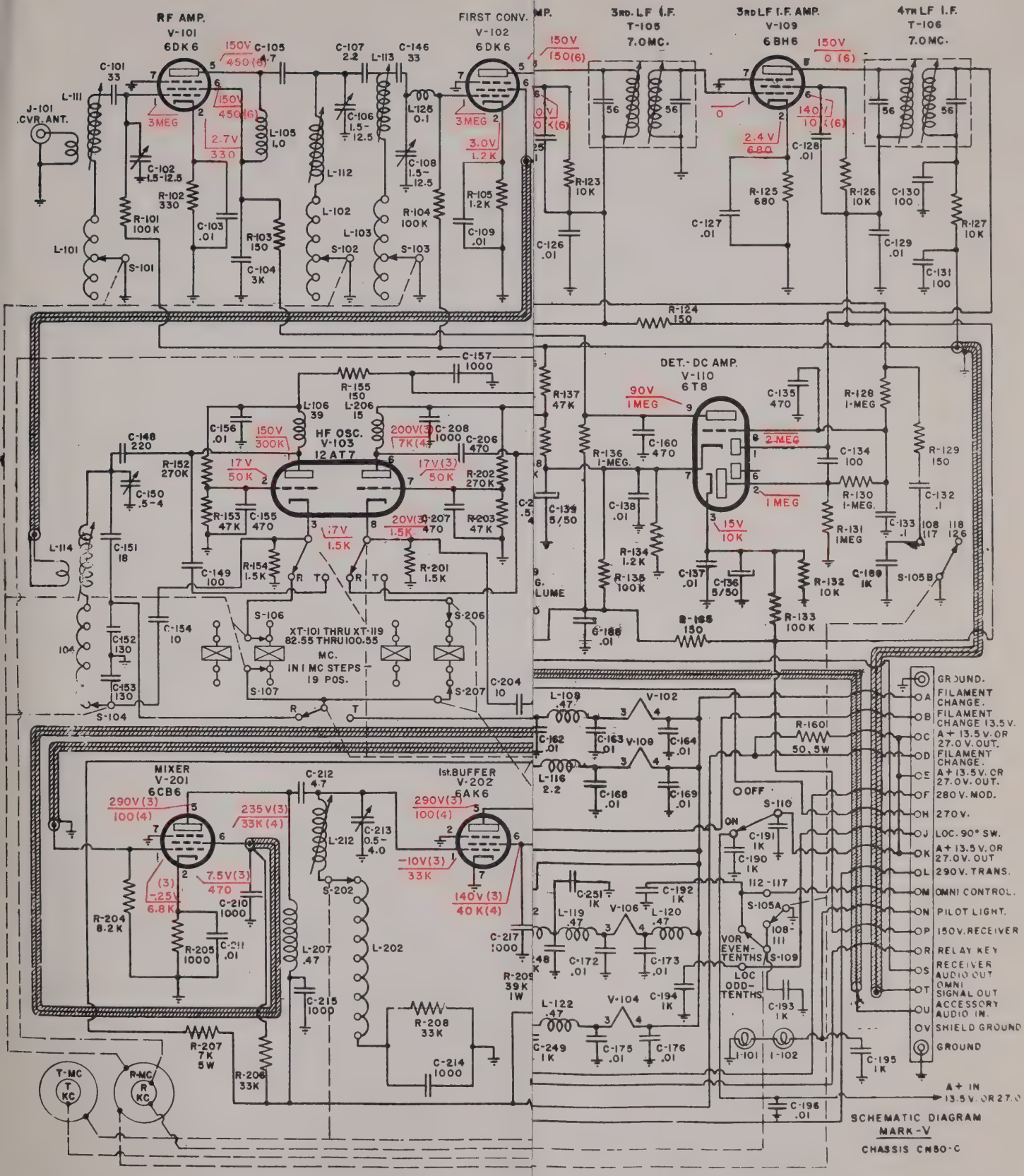


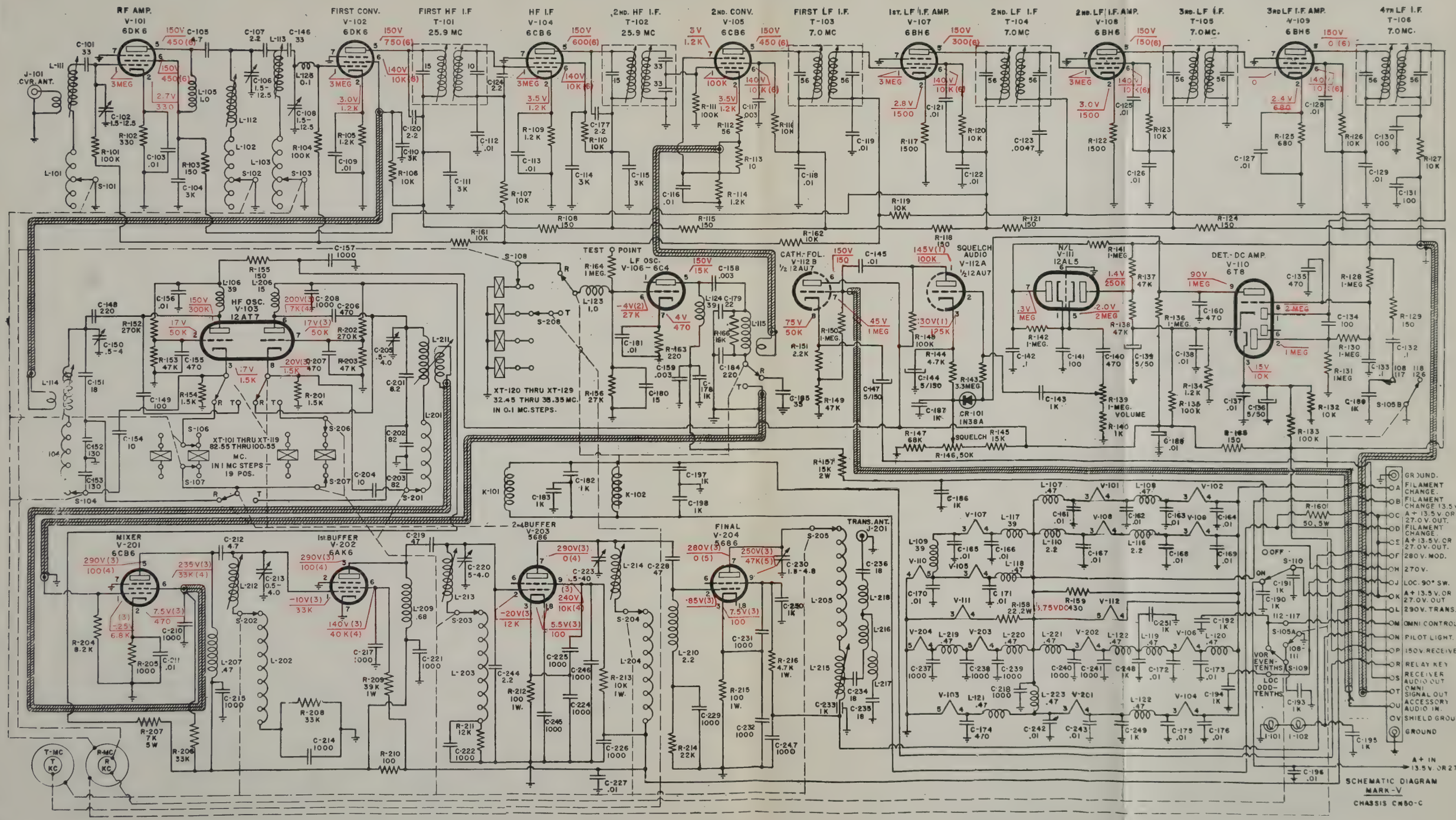
Figure 19.

SYMBOL	PART No.	DESCRIPTION
R-310,311 (T12MP-7)	31139-478	Resistor, wire, 10% 1/2 watt .47 ohms
R-310,311 (T24MP-7)	31125-129	" " " 1 watt, 1.2 "
R-312	31136-151	" carbon, " 2 " 150 "
R-313	31118-151	" wire, " 5 " 150 "
R-401,409 (T12MP-7)	31136-331	" carbon, " 2 " 330 "
R-401,409 (T24MP-7)	31110-332	" " " 1/2 " 3300 "
R-402,410 (T12MP-7)	31135-100	" " " 1 " 10 "
R-402,410 (T24MP-7)	31136-330	" " " 2 " 33 "
R-403	31136-104	" " " " " 100K "
R-404	31135-182	" " " 1 " 1800 "
R-405	31135-101	" " " 1 " 100 "
R-406	31175-3	" wire " 7 " 750 "
R-407,408 (T24MP-7)	31162-1	" " " 5 " 75 "
T-301	11272-101	Transformer, transistor driver
T-302 (T-12MP-7)	11271-101	" transistor output
T-302 (T-24MP-7)	11271-102	" " "
T-401 (T12MP-7)	11275-1	" power, toroid, DC converter
T-401 (T24MP-7)	11276-1	" " " " "
X-401	41233-103	Receptacle, 17-pin, AN-3102A-20-29P

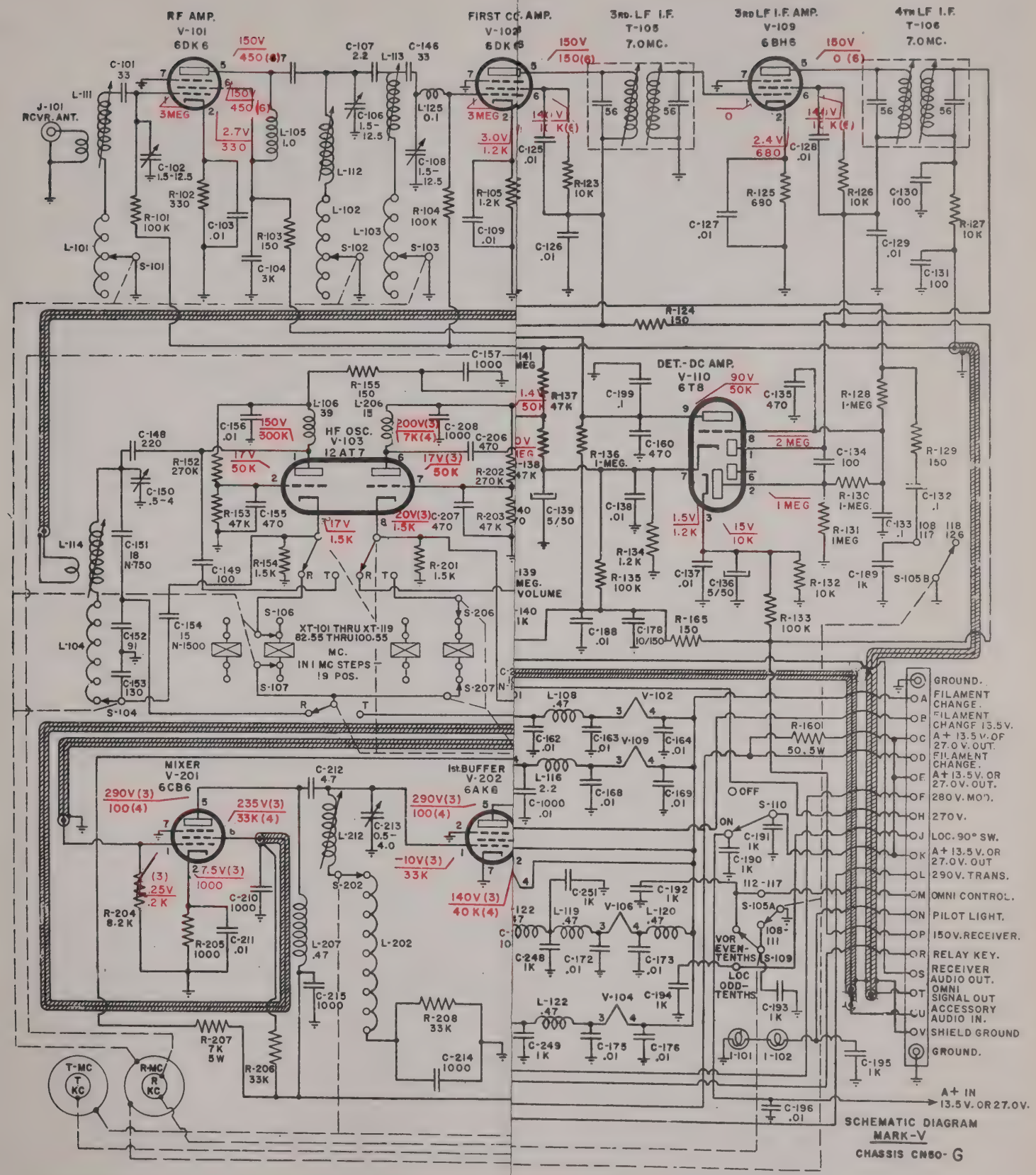
CN50C SCHEMATIC



CN50C SCHEMATIC



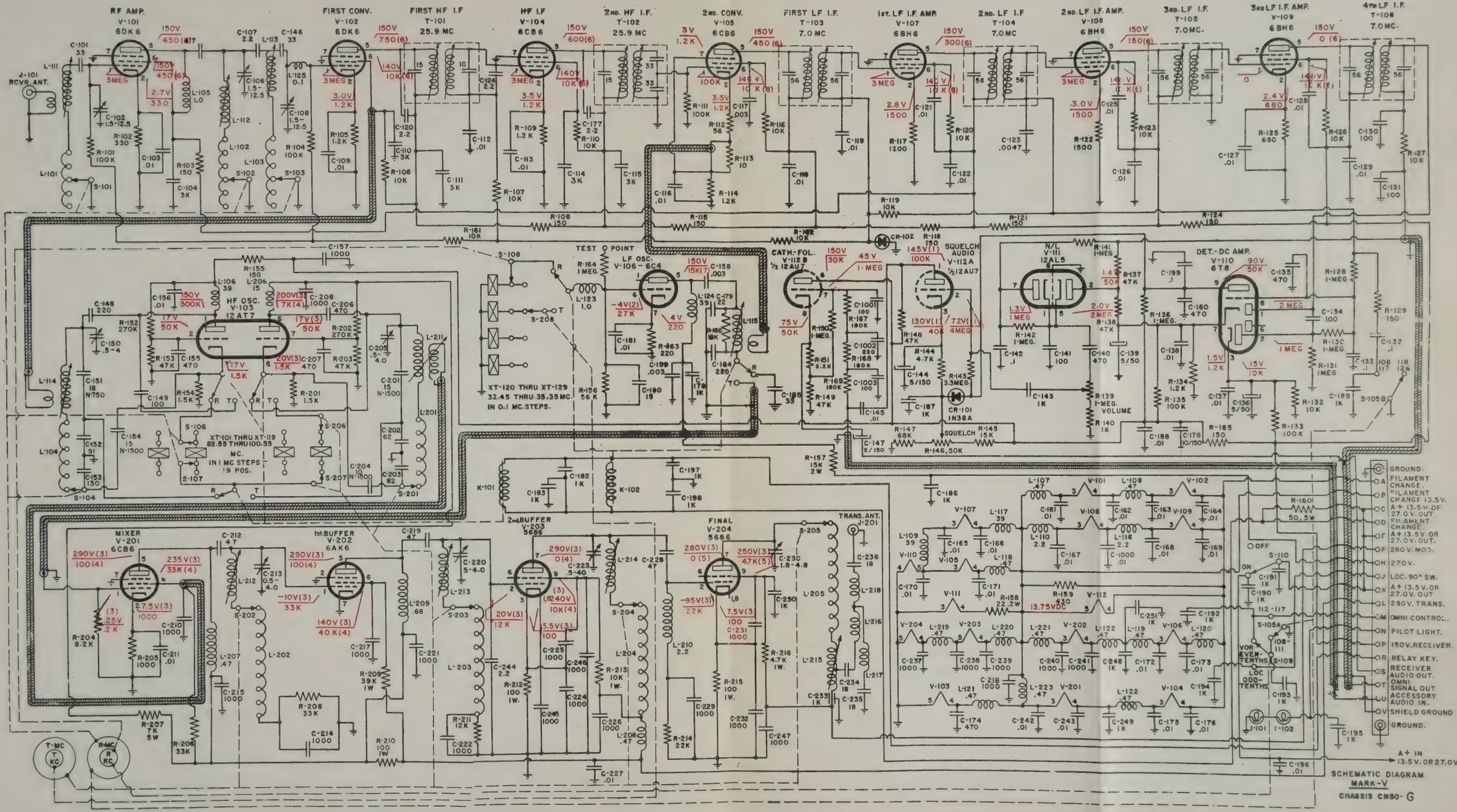
CN50G SCHEMATIC



SCHEMATIC DIAGRAM
MARK-V
CHASSIS CN50-G

VOLTAGES ABOVE LINE AND RESISTANCES BELOW LINE, S… SE WILL DECREASE.
… V. TO −8V., .00 TO .90 POSITION.
ALL DC VOLTAGES MEASURED TO GROUND, EXCEPT WHE…, MEASURED THRU .47uh. BLOCKING CHOKE.
VOLUME CONTROL AND SQUELCH CONTROL FULLY COUNT…
ALL RESISTANCES MEASURED TO GROUND, WITH CABLES D…

CN50G SCHEMATIC



SCHEMATIC DIAGRAM
MARK-V
CHASSIS CN50-G

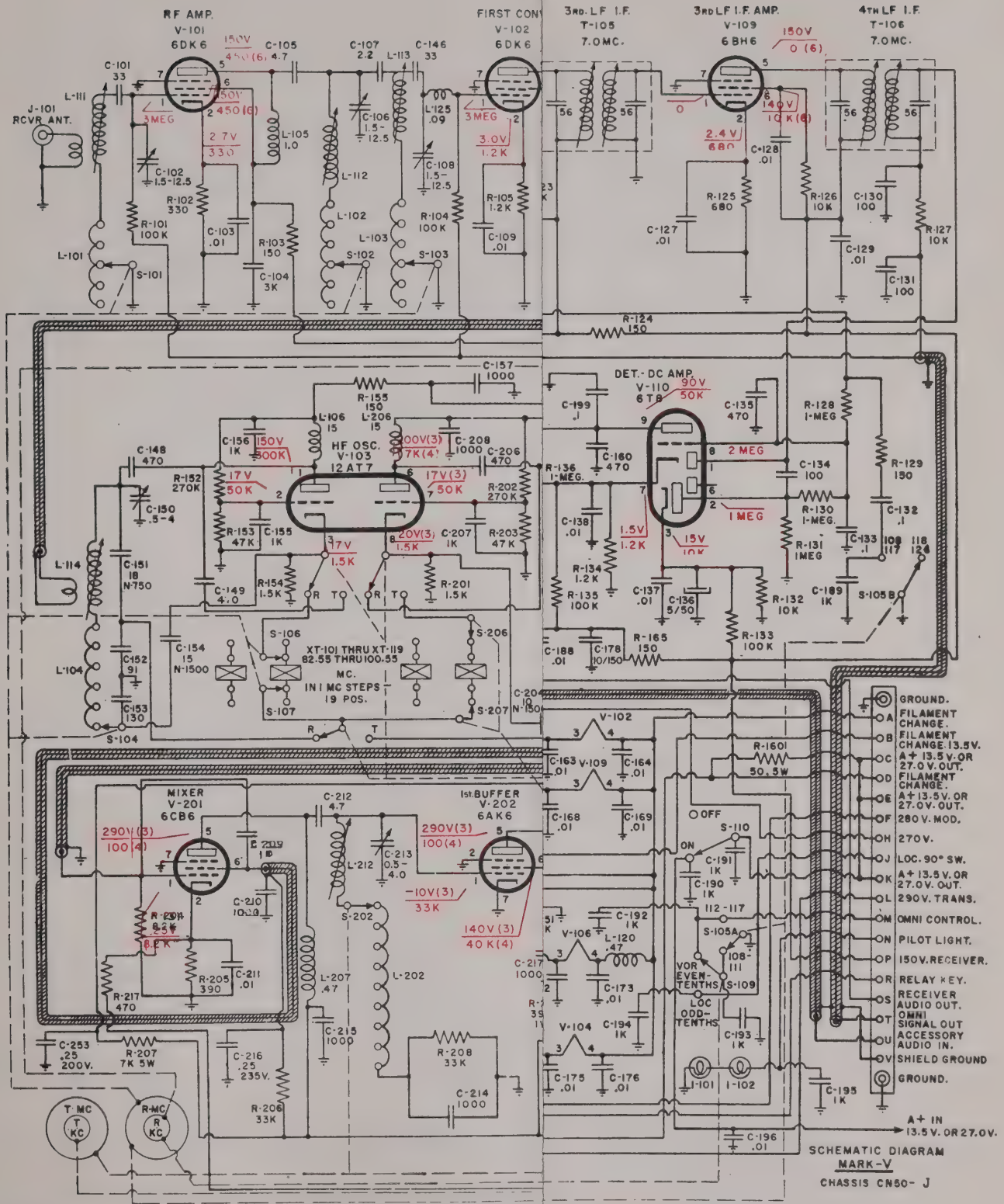
VOLTAGES ABOVE LINE AND RESISTANCES BELOW LINE, SHOWN IN RED.

ALL DC VOLTAGES MEASURED TO GROUND, EXCEPT WHERE NOTED, WITH A HIGH IMPEDANCE VOLTMETER AT 13.75 VOLTS INPUT.

VOLUME CONTROL AND SQUELCH CONTROL FULLY COUNTER CLOCKWISE, EXCEPT WHERE NOTED.

ALL RESISTANCES MEASURED TO GROUND, WITH CABLES DISCONNECTED, EXCEPT WHERE NOTED.

NOTES:
1. AS SQUELCH IS OPENED, VOLTAGE WILL DECREASE.
2. GRID VOLTAGE VARIES FROM −3V. TO −8V., .00 TO .90 POSITION.
3. TRANSMIT POSITION, KEY DOWN, MEASURED THRU .47 uh. BLOCKING CHOKE.
4. MEASURED TO PIN "L".
5. MEASURED TO PIN "F".
6. MEASURED TO PIN "P".
7. MEASURED TO PIN "H"



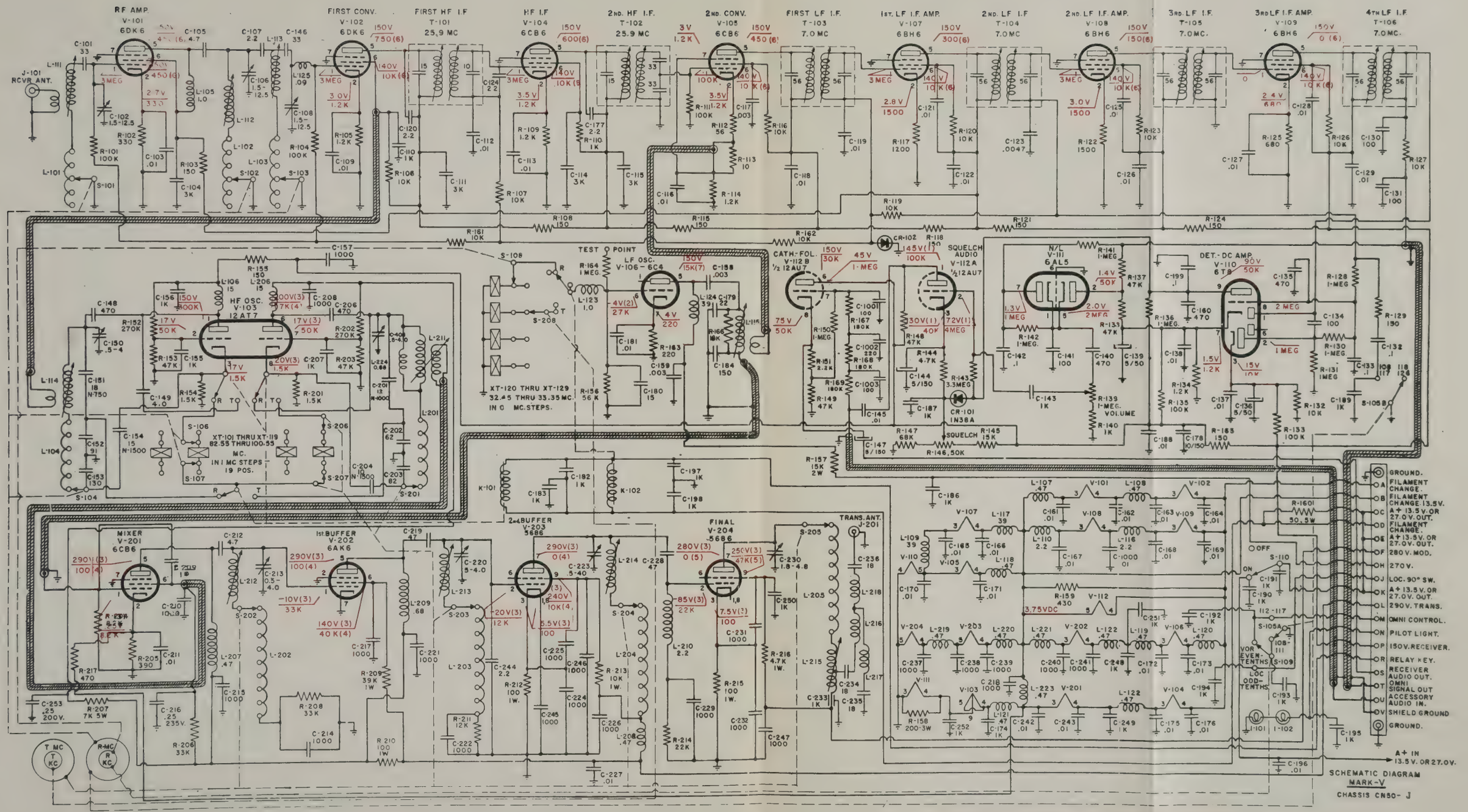
ILL DECREASE.

VOLTAGES ABOVE LINE AND RESISTANCES BELOW LINE, SHOW — 8V., .00 TO .90 POSITION.

ALL DC VOLTAGES MEASURED TO GROUND, EXCEPT WHERE N ASURED THRU .47 uh. BLOCKING CHOKE.

VOLUME CONTROL AND SQUELCH CONTROL FULLY COUNTER

ALL RESISTANCES MEASURED TO GROUND, WITH CABLES DISC



VOLTAGES ABOVE LINE AND RESISTANCES BELOW LINE, SHOWN IN RED.
ALL DC VOLTAGES MEASURED TO GROUND, EXCEPT WHERE NOTED, WITH A HIGH IMPEDANCE VOLTMETER AT 13.75 VOLTS INPUT.
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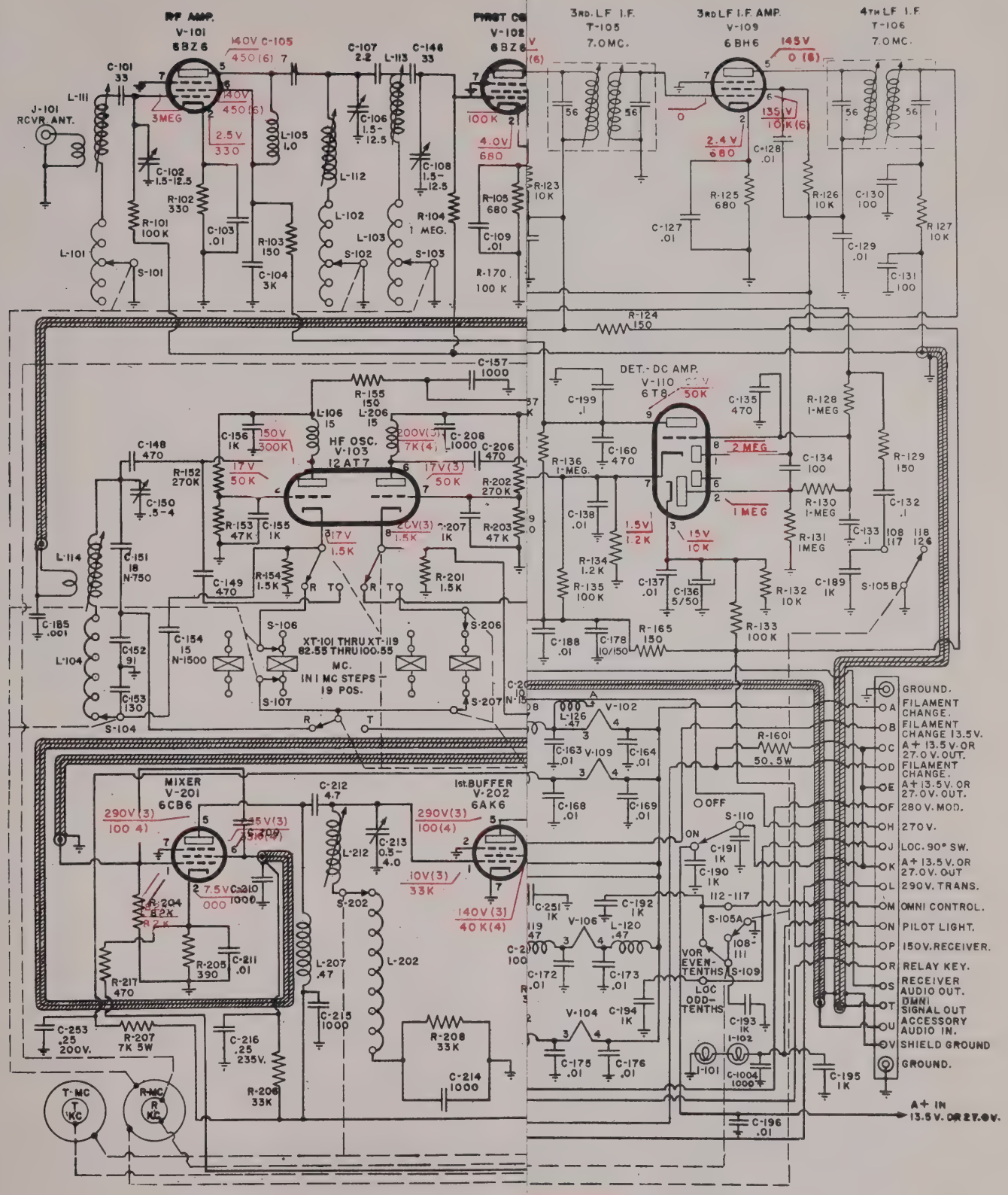
5. MEASURED TO PIN "F".
6. MEASURED TO PIN "P".
7. MEASURED TO PIN "H"

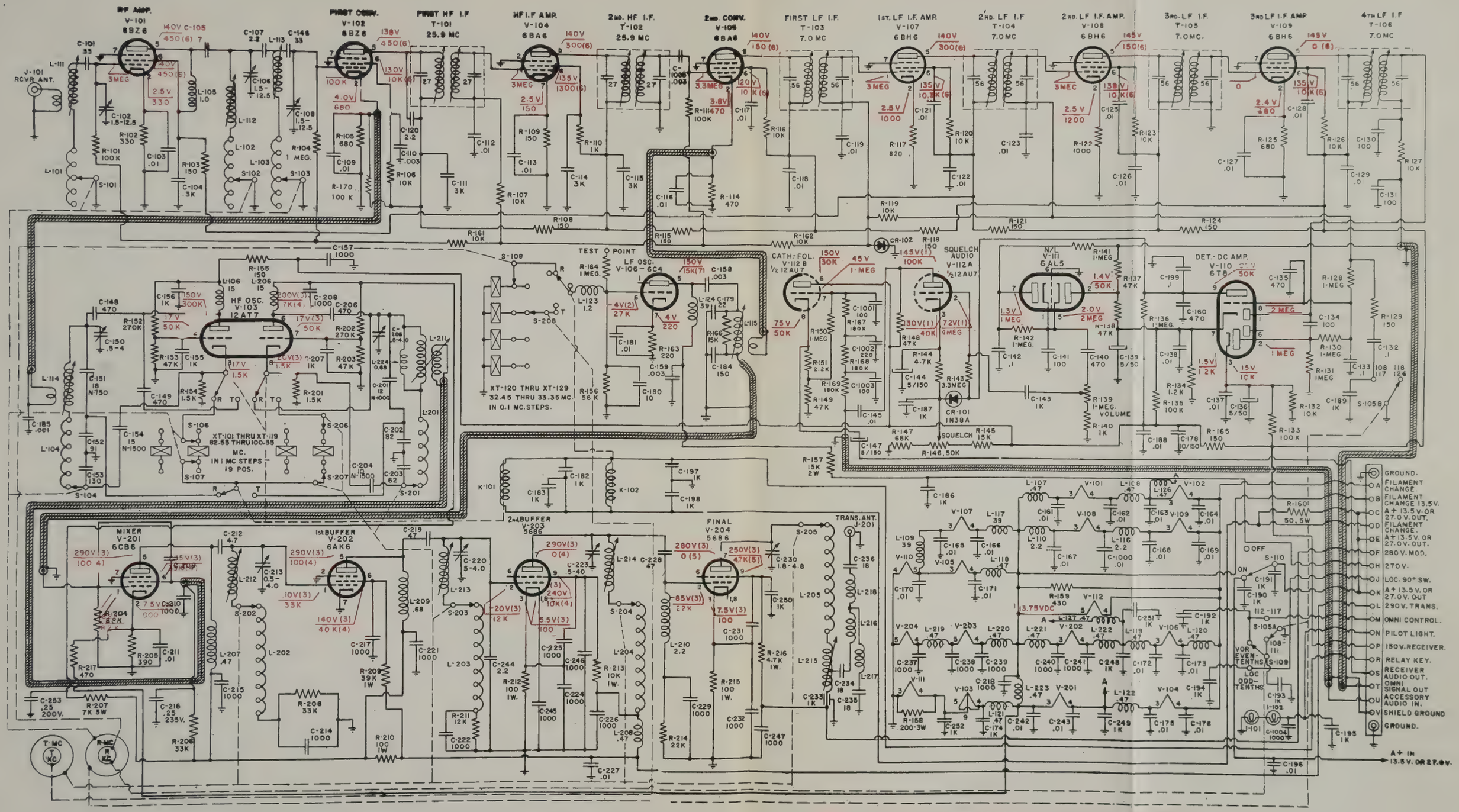


DECREASE.
V., .00 TO .90 POSITION.
RED THRU .47uh. BLOCKING CHOKE.

VOLTAGES ABOVE LINE AND RESISTANCES BELOW LINE, SH
ALL DC VOLTAGES MEASURED TO GROUND, EXCEPT WHER
VOLUME CONTROL AND SQUELCH CONTROL FULLY COUNTE
ALL RESISTANCES MEASURED TO GROUND, WITH CABLES DI

SCHEMATIC DIAGRAM
MARK-V
CHASSIS CN50-K

Figure 19



VOLTAGES ABOVE LINE AND RESISTANCES BELOW LINE, SHOWN IN RED.

ALL DC VOLTAGES MEASURED TO GROUND, EXCEPT WHERE NOTED, WITH A HIGH IMPEDANCE VOLTMETER AT 13.75 VOLTS INPUT.

VOLUME CONTROL AND SQUELCH CONTROL FULLY COUNTER CLOCKWISE, EXCEPT WHERE NOTED.

ALL RESISTANCES MEASURED TO GROUND, WITH CABLES DISCONNECTED, EXCEPT WHERE NOTED.

NOTES:
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4. MEASURED TO PIN "L".
5. MEASURED TO PIN "F".
6. MEASURED TO PIN "P".
7. MEASURED TO PIN "H"

SCHEMATIC DIAGRAM
MARK-V
CHASSIS CN50-K

Figure 19

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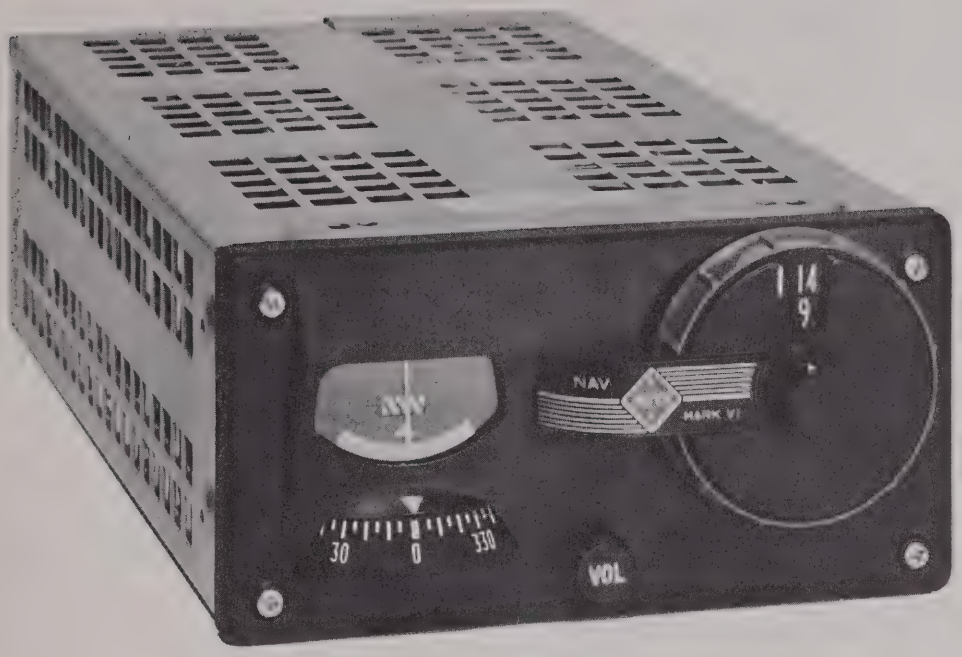

NARCO MARK VI

OPERATION • INSTALLATION and SERVICE MANUAL

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

ce $1.00

14250-012

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SECTION I

GENERAL DESCRIPTION

A. Introduction

The NARCO MARK VI VHF receiver/navigation unit is a completely self-contained, crystal-controlled instrument designed to provide accurate VOR/ILS navigation information. The receiver has 190 crystal-controlled channels, providing crystal tuning of all NAV/COMM frequencies between 108.0 and 126.9 MC, in 100 kc steps.

This unit may be used by itself to provide navigation information or to complement any VHF NAV/COMM system. When used with two Mark V transceivers in the "2½ Mark V System," the Mark VI provides the primary navigation facility and a secondary or standby receiver.

The panel mounted unit may be located anywhere in the instrument panel area that provides convenient access to the front panel, which contains all operating controls. Should there be a more convenient meter location or a need for an additional VOR/ILS indicator, provision has been made for the operation of a remote ILS indicator.

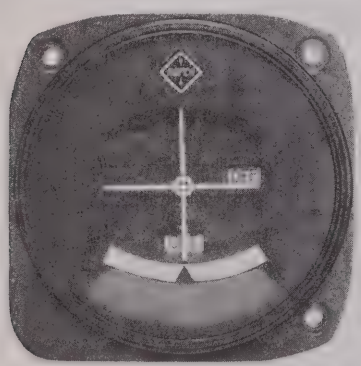


Figure 1
ID-5
VOR/ILS
INDICATOR

The NARCO ID-5 cross-pointer indicator is designed for use in this application. The indicator may be used with the Mark VI and a suitable glide slope receiver to provide complete VOR and ILS information. Automatically selecting the correct NAV/COMM function, the Mark VI receiver channel selector also can be used to channel a glide slope receiver.

Using hybrid tubes and transistors, the Mark VI requires no power supply and is powered directly from the primary voltage source of the aircraft. The Mark VI may be installed in either a 12 volt or 24 volt aircraft system, being internally convertible to operate with either primary voltage supply.

B. Specifications

RECEIVER

Frequency Coverage - 190 channels, crystal-controlled, 100 KC spacing, 108.0 - 126.9 MC.

Sensitivity - 2 microvolts for 6db Signal plus noise to noise ratio.

Over-all Selectivity -
6db — 42 KC total bandwidth
60db — 170 KC total bandwidth
Double conversion superhetrodyne

Image Rejection - 70 db.

AVC - Within 5 db, 10 - 10,000 microvolts.

Audio Output - 4 Ohm speaker or dual 600 ohm headphones. Up to 4 watts speaker audio available.

NAVIGATION

Omni Course Width - 30 degrees with standard omni signal.

Omni Course Accuracy - 2 degrees under standard conditions.

Omni To-From Sensitivity - Usable indication at 6 microvolts input.

ILS Localizer - Needle Deflection - Standard meter scale characteristics.
Warning Flag - To-From flag shows full "To" deflection with 6 microvolts input.

External Meters - Provision has been made for two external L-R 1000 ohm meter movements and one 100 ohm To-From meter movement.

ILS Glide Path - Channel selection wiring provided for 10 or 20 channel glide slope receiver. Glide slope receiver activation on proper ILS channel also provided.

GENERAL

Weight - 6.5 pounds.

Size - 3-5/32" H. x 6-9/32" W. x 12¼" L.

Power Drain - 13.75 VDC - 3.5A.
27.50 VDC - 1.8A.

SECTION II

OPERATION

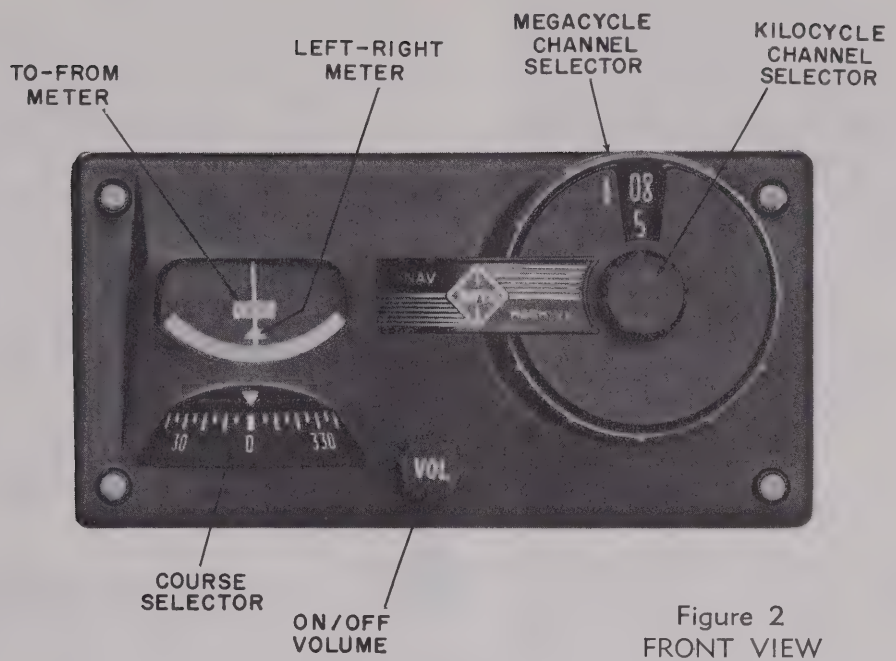


Figure 2
FRONT VIEW

A. On-Off Volume

Rotating the small knob labeled "VOL" in a clockwise direction from its extreme counter-clockwise (OFF) position turns the unit on. Further clockwise rotation increases the audio volume.

B. Receiver Channel Selection

Select the desired receiving channel, either navigation or communication, by turning the large outer knob of the channel selector until the correct megacycle channel appears in the window, then turning the small inner knob until the correct tenth-megacycle channel appears just below.

Navigation Frequencies

108.1 through 111.9 MC (odd tenth-megacycle channels)—ILS Localizer frequencies.
108.0 through 111.8 MC (even tenth-megacycle channels)—VOR (VHF Omni Range) frequencies.
112.0 through 117.9 MC (all tenth-megacycle channels)—VOR (VHF Omni Range) frequencies.

Communication Frequencies

118.0 through 126.9 MC (all tenth-megacycle channels)—Control Tower, Approach Control, Unicom, etc.

C. VOR/ILS Course Selection

After selecting the desired omni station (using the receiver channel selector), any radial TO or FROM the station may be selected by turning the course selector until the desired radial is centered below the fiducial mark on the front panel.

D. Homing Procedure

Channel to the desired VOR station on the receiver. The identification will be heard in the earphones or loudspeaker.
Rotate the course selector dial until the LEFT-RIGHT needle centers and the TO-FROM flag reads "TO." Two course selector settings (180° apart) will cause the L-R meter to center, but only one will cause the T-F flag to read "TO."

Turn the aircraft until the magnetic compass reads the same as the course selector dial. The omni indications do not depend on the attitude or heading of the aircraft, but on its position with respect to the ground station, and so will not change as the aircraft is turned to the magnetic heading which corresponds to the course to the ground station.

Fly the aircraft along the course indicated by the course selector, making corrections to the left or right as indicated by the L-R needle. The needle

points to the selected track along the ground, so if the needle points LEFT, correct the aircraft heading to follow a track somewhat to the left; make an opposite correction for needle deflections to the right.

If you are too far out or too low to receive adequate signal from the omni station, the needle may wander or respond to course changes slowly. Try to integrate the information, using the average needle indication and maintaining the indicated heading, unless the needle shows a tendency to remain in a LEFT or RIGHT position. The difference between the selected course and the magnetic heading of the aircraft necessary to keep the needle centered consistently is the wind correction angle (plus any error in the compass).

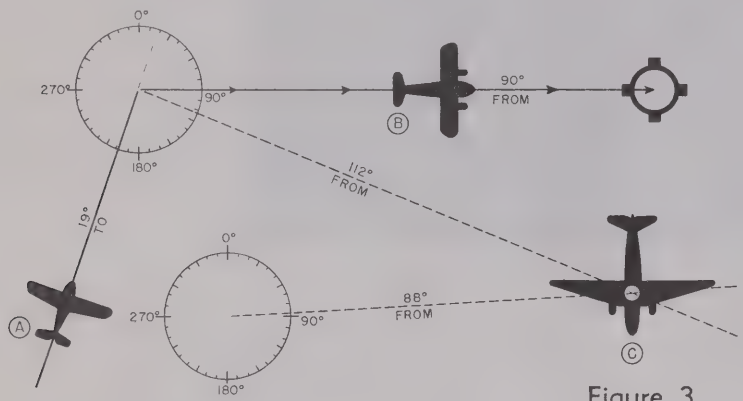


Figure 3

Fly inbound TO an Omni station from any point on the compass by riding the "TO" radial.

Fly outbound FROM an Omni station to a desired destination on a pre-selected "FROM" Omni radial.

Determine your position by taking quick bearings on two Omni stations at least 30° apart.

If, for some reason, the aircraft gets very far off course, as indicated by the L-R indicator, the course selector can be reset to center the L-R needle and the heading of the aircraft changed to agree with the course selector. This will establish a new track to the station, which is a straight line from the off-course point to the station and is shorter than flying back to the original course.

Close to the VOR station, the course becomes "tight" and increasingly difficult to hold. Station passage is indicated by this gyration of the L-R needle, and by the T-F flag changing to "FROM."

E. Course from Station

Any desired course outbound FROM the station may be set on the course selector and followed by correcting the heading of the aircraft to keep the L-R needle centered with the T-F meter reading "FROM." As the distance from the station increases in flying outbound, the signal will gradually grow weaker as indicated by a decreasing deflection of the T-F flag. When the signal becomes so weak as to cause the red sector of the flag to half fill the T-F window, it is no longer reliable and another Omni station should be selected.

F. Orientation or Position Fixing

The Omni-Range system can be used for triangulation (obtaining a "fix") when the aircraft's location is in doubt.

Bearings to the omni ground stations do not depend on the attitude or heading of the aircraft and can be taken easily and accurately in the rough air; no heading correction is necessary. To use the omni system for triangulation, the following procedure is recommended:

1. Choose the two omni stations that are as near 90° apart as possible, and which are within 50 miles of your probable location. Greater distances can safely be used at higher altitudes.

2. Tune in No. 1 omni station and check its identification. Turn the course selector until the L-R needle centers and the T-F flag reads "FROM." Record the station and the bearing.

3. Channel to No. 2 station and repeat step 2 above, but for No. 2 station.

4. Plot the two bearings on the chart of the area; the aircraft position is at the intersection of the two bearings. Additional bearings from other stations are not necessary, but will improve the accuracy of the "fix."

G. ILS Localizer Operation

Tune in the desired localizer station, referring to the AIRMAN'S GUIDE or appropriate charts for the frequency, courses and other pertinent data.

The L-R needle will center when on-course, and will point toward the track when approaching on the prescribed in-bound localizer course, but will deflect in a reverse sense when flying an outbound localizer front course or when making an inbound approach on the back course.

The T-F flag is used as an indication of signal strength in this application, and will deflect to the "TO" position only.

Channelling the Mark VI to a localizer frequency will automatically channel a suitable glide slope receiver if the two units are properly interconnected (refer to Section III, Installation).

SECTION III

INSTALLATION

A. Equipment Initially Supplied by Narco

1. Mark VI VHF Navigation equipment, in case.
2. Receiver antenna connector, BNC, Narco Part No. 41152-1.
3. Mating 11-pin connector assembly (includes load resistors for metering circuits, jumper for un-dimmed panel lights), Narco Part No. 55048-101.
4. Tools: Hex wrenches for front panel knobs and internal detents, Narco Part No. 84045-2 and 84045-3.
5. Instruction manual, Mark VI.

B. Equipment Available From Narco

1. Antennas:
   VRP-15A, Mast-type VOR receiving antenna, Narco Part No. 71151.
   VRP-37, fin-mounting VOR receiving antenna, Narco Part No. 71126.
2. Accessories:
   Narco model ID-5 Cross-pointer ILS indicator (for use with Mark VI and a glide slope receiver, or as a remote indicator.)
3. Headphone jack, Narco Part No. 41127-1.

C. Equipment required, but not supplied by Narco

1. Headphones—low impedance type, 300 to 1000 ohms.
2. Loudspeaker—3 to 4 ohms nominal voice coil impedance.
3. 14-pin mating connectors (US Components, M1-14F/M1-14HR, M1-14M/M1-14HR, or equivalent) for connecting automatic glide slope switching cable of Mark VI to a glide slope receiver.

D. Cable Fabrication

External Meter—Dimmer—Audio Cable

The connections to the 11-pin connector, Narco Part No. 55048-101 are shown in Figure 4.

Two 1000 ohm resistors are connected in parallel with the internal left-right meter movement through pins 9 and 11 for installations that do not involve external metering. Up to two external left-right meters, having standard 1000 ohm movements, may be installed by replacing either one or both resistors with either one or two meters.

One 100 ohm resistor is connected in parallel with the internal to-from flag movement through pins 6 and 8. An external, standard 100 ohm, to-from

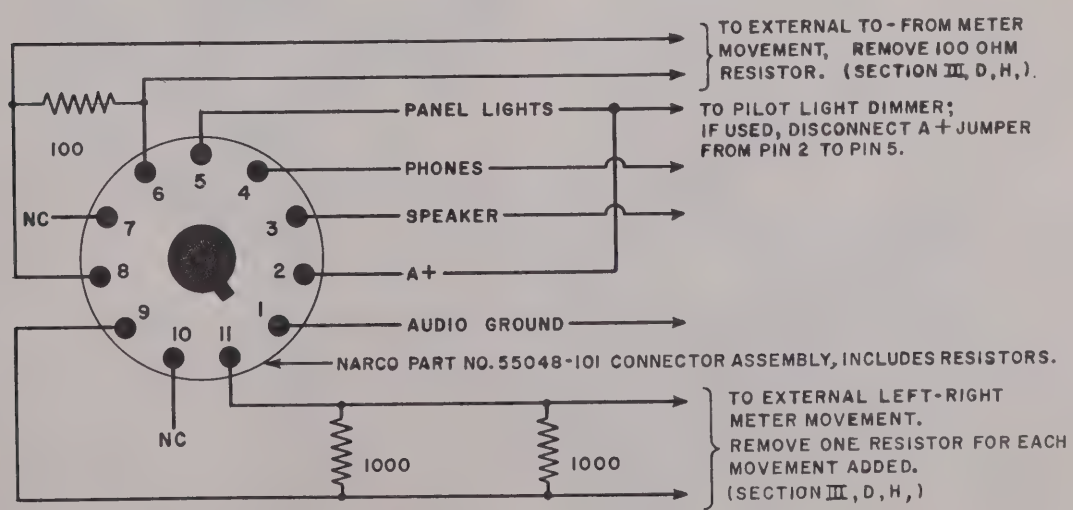


Figure 4 — INTERCONNECTING CABLE WIRING DIAGRAM

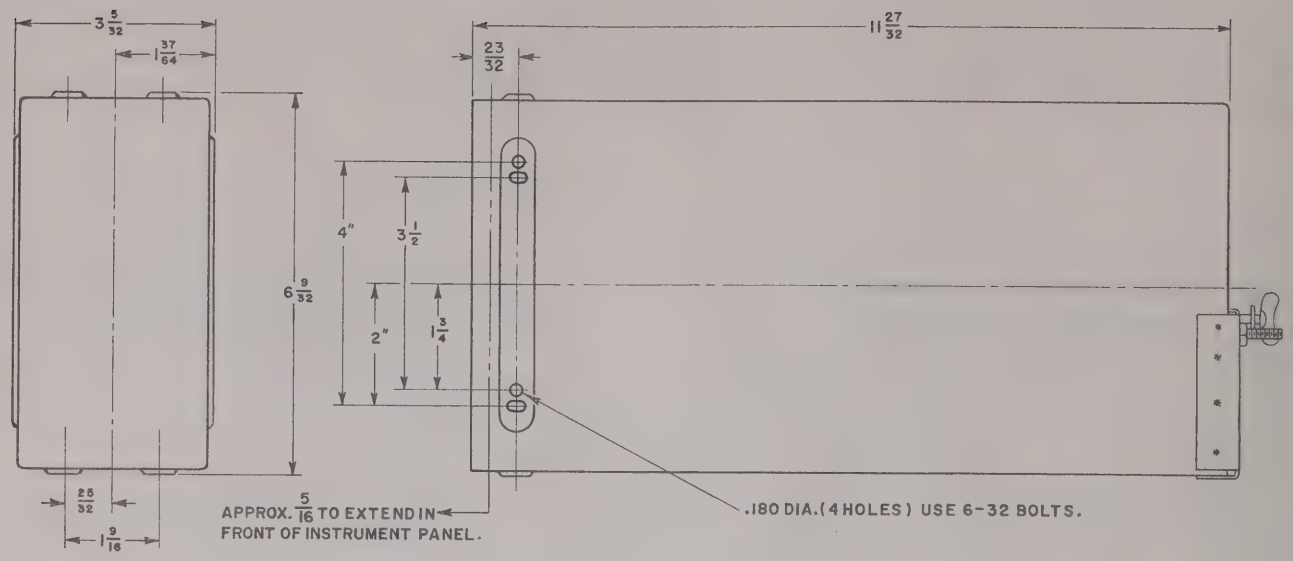
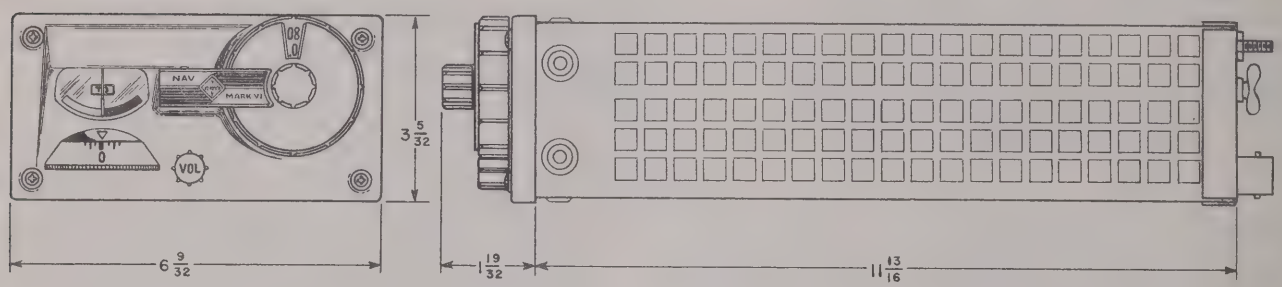


Figure 5 — CASE DIMENSIONS



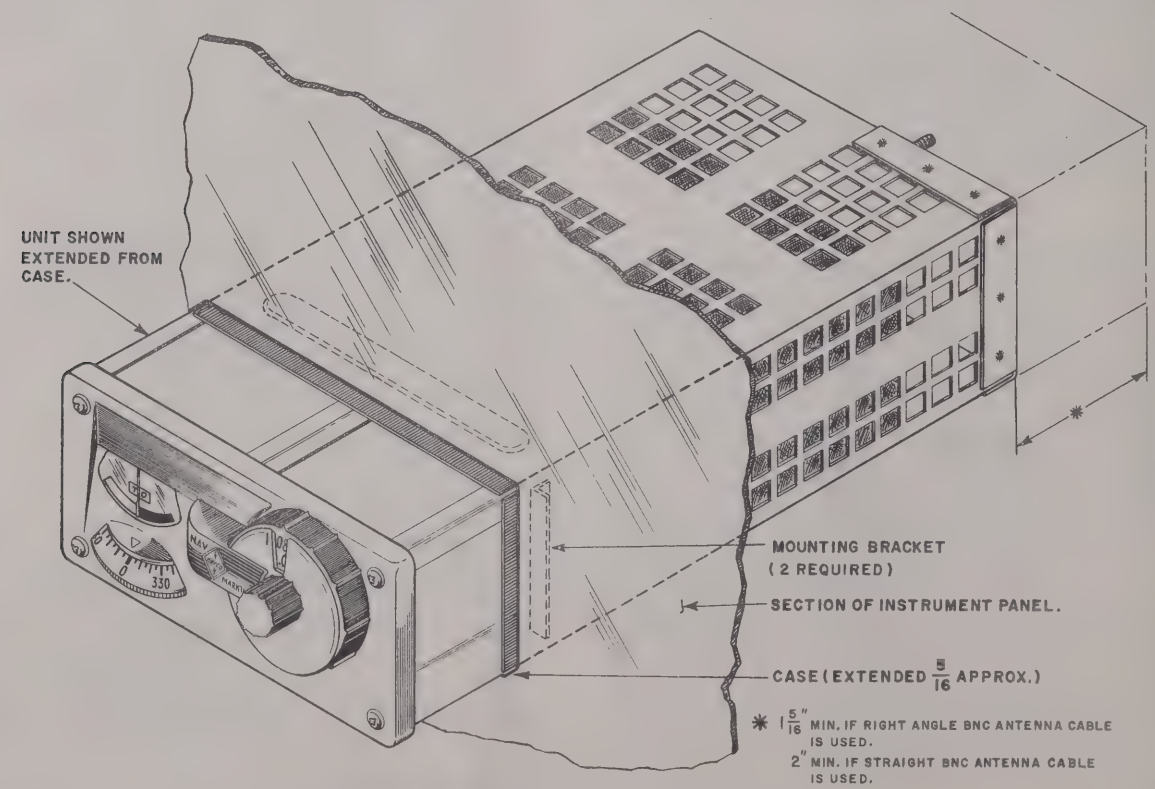

UNIT SHOWN EXTENDED FROM CASE.
MOUNTING BRACKET (2 REQUIRED)
SECTION OF INSTRUMENT PANEL.
CASE (EXTENDED 5/16 APPROX.)
* 1 5/16" MIN. IF RIGHT ANGLE BNC ANTENNA CABLE IS USED.
2" MIN. IF STRAIGHT BNC ANTENNA CABLE IS USED.

Figure 6 — MOUNTING DIAGRAM

movement may be installed by replacing the resistor with the meter.

If no external metering is desired, the resistors are the only connections made to pins 6, 8, 9, and 11.

The panel lights may be connected to the aircraft's dimmer system by removing the jumper wire from pin 2 and pin 5, connecting pin 5 to the dimmer system.

No shielded wires are required; wire size should be #22 or larger.

Glide Slope Switching Cable

The pigtail cable extending from the rear of the Mark VI (Figure 12) may be used to control and channel a Glide Slope receiver. Ten of these wires apply a ground, selecting the suitable glide slope frequency when the Mark VI is channelled to the paired LOC frequency. For example, when the Mark VI is channelled to 108.1 Mc. the "black" wire in this cable is grounded, and could be connected to the Glide Slope receiver to select the 334.4 Mc. channel. The other channels are paired as follows.

Cable Wire	LOC Freq. (MC)	G.S. Freq. (MC)
Black	108.1 or 110.1	334.4
Brown	108.3 or 110.3	335.0
Red	108.5 or 110.5	329.6
White & Red	108.7 or 110.7	330.2
Orange	108.9 or 110.9	330.8
Yellow	109.1 or 111.1	331.4
Green	109.3 or 111.3	332.0
White & Green	109.5 or 111.5	332.6
Blue	109.7 or 111.7	333.2
White & Blue	109.9 or 111.9	333.8
Violet	A to B Bank Switch	
Gray	Glide Slope Receiver Activation	
White	Ground	

The violet wire is grounded in the 108 and 111 Mc. positions and may be used to activate a relay in the glide slope system to make ten additional glide slope frequencies available. The ten pairs of localizer channels would be split to match the glide slope frequencies as follows:

LOC Freq. (MC)	G.S. Freq. (MC)
108.1	334.7
108.3	334.1
108.5	329.9
108.7	330.5
108.9	329.3
109.1	331.4
109.3	332.0
109.5	332.6
109.7	333.2
109.9	333.8
110.1	334.4
110.3	335.0
110.5	329.6
110.7	330.2
110.9	330.8
111.1	331.7
111.3	332.3
111.5	332.9
111.7	333.5
111.9	331.1

Activation of the Glide Slope receiver, by applying A-plus to a relay, is accomplished through the gray wire, which has an A-plus potential of 13.75 or 27.5 VDC on localizer frequencies. A constant ground is provided by the white wire.

Mating 14-pin connectors (US Components, M1-14F/M1-14HR, M1-14M/M1-14HR, or equivalent) may be used to connect the cable to the Glide Slope receiver.

E. Panel Installation

1. The views shown in Figure 6 indicate the normal method of mounting the Mark VI. If the case is to be installed from the front of the instrument panel, a cutout 3-3/16" x 6-5/16" should be provided in the instrument panel. The trim panel of the unit is not large enough to extend over this opening, when this mounting method is used.

   If the case is to be installed from the rear of the instrument panel, a cutout 3-1/16" x 6-3/16" should be provided in the panel. With this method of mounting, the trim panel will cover the opening.

2. Remove the set from the case and install the case in this opening, using mounting brackets, stove head screws and stop-nuts. The front edge of the case should extend in front of the panel about 5/16".

3. Install a rear support from the stud on the rear of the case to some nearby structural member. Allow sufficient space behind the case for cables, and for access to the air-lock fastener.

4. Slide the set into the case, feeding the pigtail cables through the cutout, and secure with a quarter-turn of the air lock fastener on the rear of the case.

F. Receiver Audio Output

The audio output power from the receiver may be used to power an external three ohm speaker or up to two sets of low impedance (600 ohm) headphones. The output may be connected into any normal audio system in which the audio from two or three units is switched between speaker and phones. The Mark VI audio can be controlled by the NARCO VP-9 Switchmaster by connecting the audio output from the meter/audio cable to one of the inputs. However, for optimum performance in multiple installations it may be preferable to use a speaker amplifier.

G. Primary Power

An acceptable aircraft circuit protector should be installed between the primary power source and the red #16 A-plus input lead, extending from the audio-meter pigtail at the rear of the unit. Suitable fuse sizes are: 13.75 VDC, 5 amp; 27.5 VDC, 3 amp. The primary power lead from the A-plus source to the input on the panel unit should be at least #16 AWG for a length of 2' or less; #14 AWG for a length of 2' to 4'; #12 AWG for lengths over 4'.

A good primary ground connection should be provided by grounding the case to the airframe. The wire size of the ground connection should be the same size as the A-plus input.

12/24 VOLT CONVERSION

Voltage conversion is easily facilitated by changing the audio output transistors, Q-102, Q-103 and either removing or installing jumper connections, depending on the voltage.

12 VOLT TO 24 VOLT

Remove Q-102 and Q-103 (Clevite 1237) transistors from rear panel of the unit (refer to Figure 14) and replace with 27.5 volt (Clevite 1237A) transistors. Remove the jumper wires connected across R-141, R-142, R-145, and R-248. Reconnect the lamps in series as shown in Figure 17; reconnect the filaments in series on the long terminal strip in the bottom rear of the receiver.

24 VOLT TO 12 VOLT

Remove Q-102 and Q-103 (Clevite 1237A) transistors from the rear panel of the unit (refer to Figure 14) and replace with 13.75 volt (Clevite 1237) transistors. Connect insulated jumper wires across R-141, R-142, R-145, and R-248. Reconnect the lamps in parallel as shown in Figure 14; reconnect the filaments in parallel on the long terminal strip in the bottom rear of the receiver.

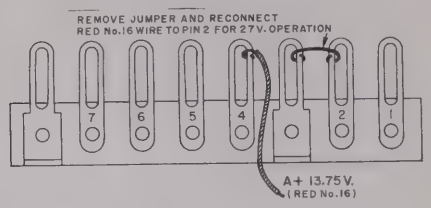


Figure 7 — TL-102

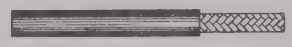
H. External Metering

Provision has been made in the Mark VI system for external VOR/ILS metering. Should there be a more convenient panel location for the NAV indicator, up to two 1000 ohm Left-Right meter movements and one 100 ohm To-From meter movement may be added.

The Narco model ID-5 cross-pointer ILS indicator is designed to be used in this application. In addition to the standard Left-Right and To-From movements, there is a glide slope indicator and alarm flag, suitable for use with a glide slope receiver. Refer to Section III, D and Figure 4 for the proper connection of the VOR/ILS movement.

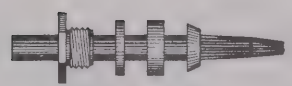
The second 1000 ohm Left-Right meter movement may be used to drive an approach coupler or automatic pilot, should it be desired.

The meter is a standard 3-1/8" instrument and may be installed in the normal instrument cut-out.



1. Trim cable jacket 19/64" for RG-58A/U.

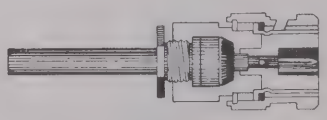
2. Fray shield and strip inner dielectric 1/8". Tin center conductor.



3. Taper braid and slide nut, washer, gasket and clamp over braid. Clamp should be squarely against cable jacket.

4. Comb out braid, fold back over clamp and trim as shown.

5. Slip contact onto center conductor and solder, taking care not to swell dielectric with excessive heat, thereby preventing its entrance into conductor body.



6. Push this assembly into the body as far as it will go. Holding the cable and shell rigid, tighten the nut into body using the proper wrench.

Figure 8 — BNC CABLE CONNECTOR ASSEMBLY

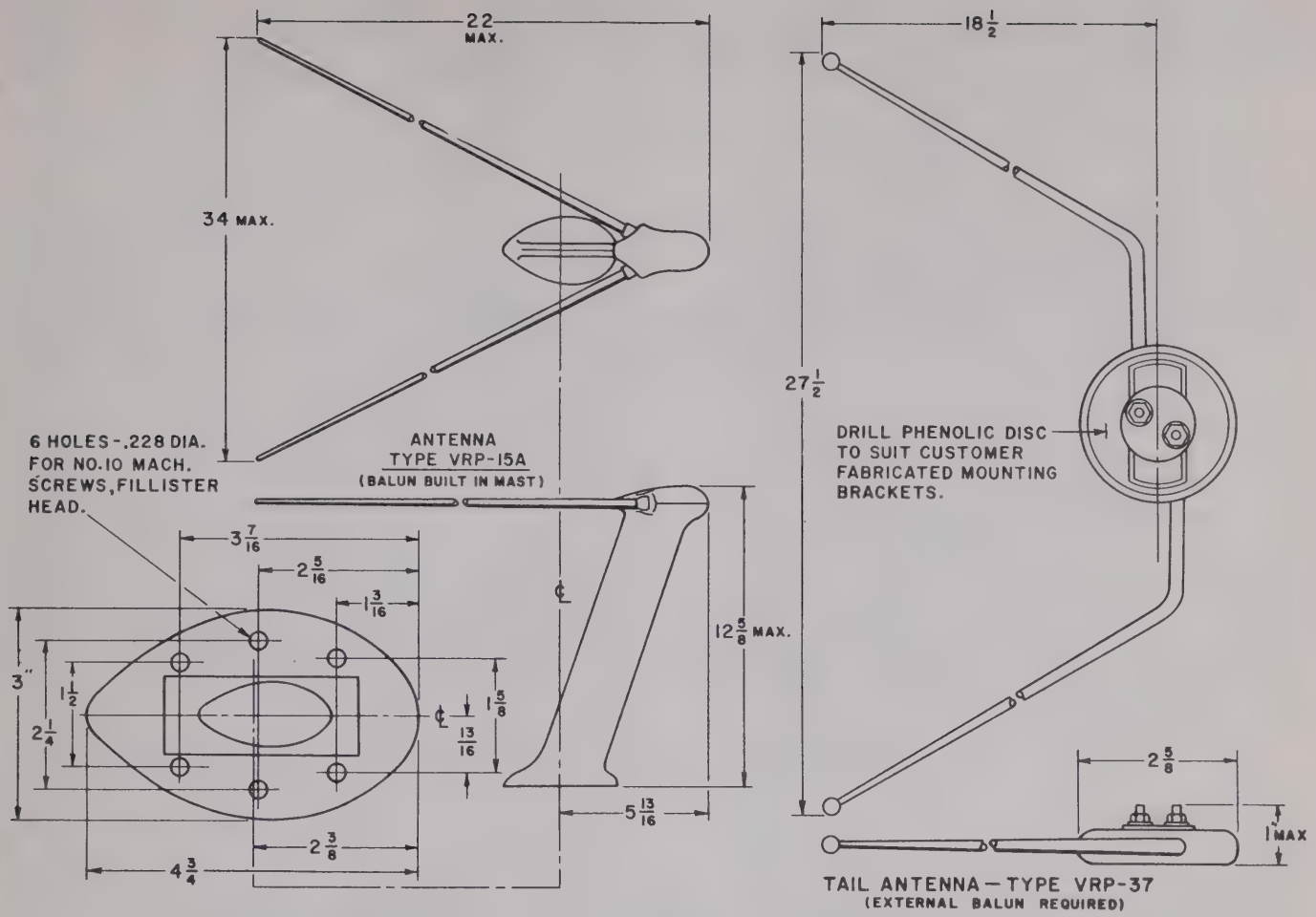


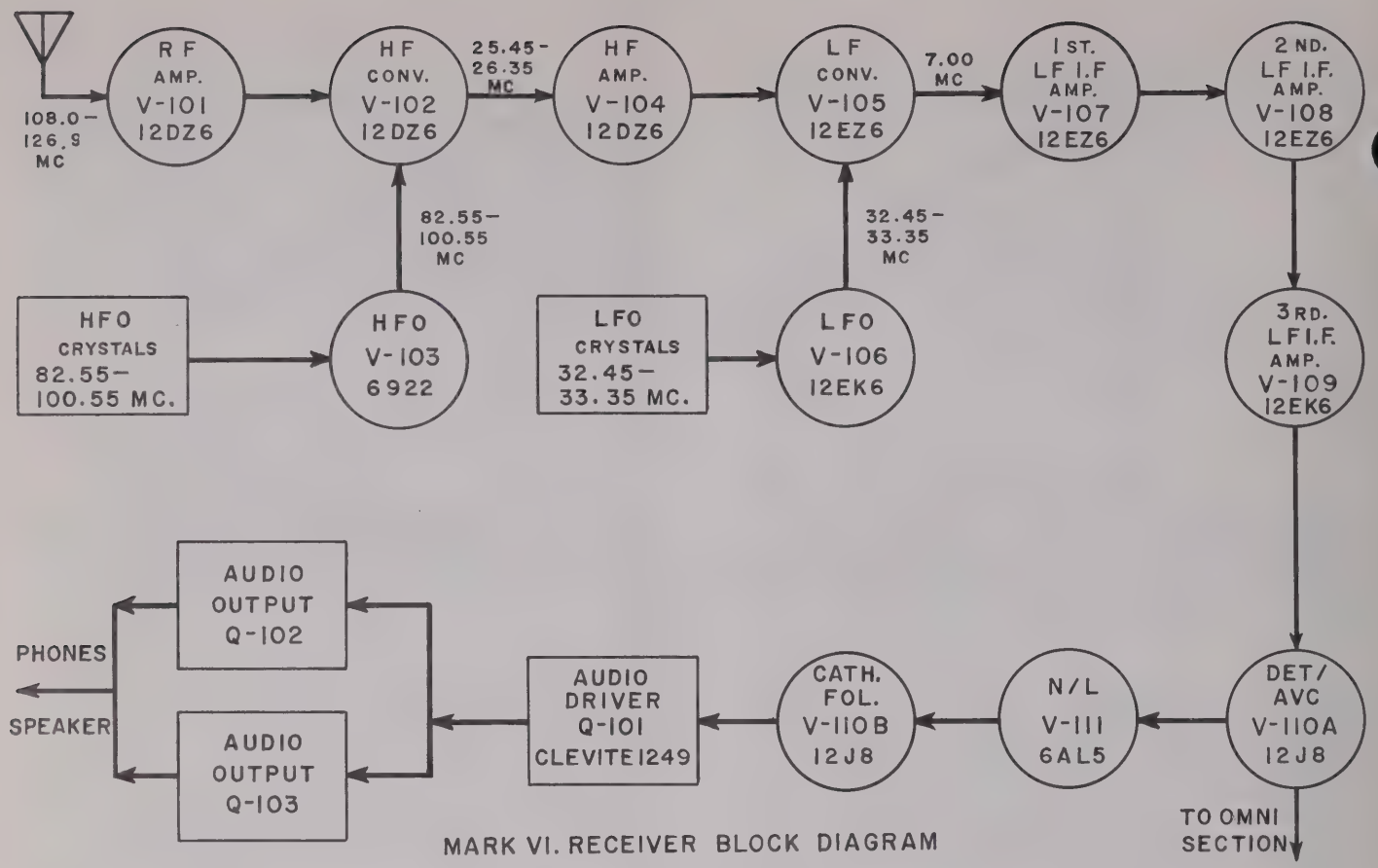
Figure 9 — ANTENNA MOUNTING DIAGRAM

I. Antenna Installation

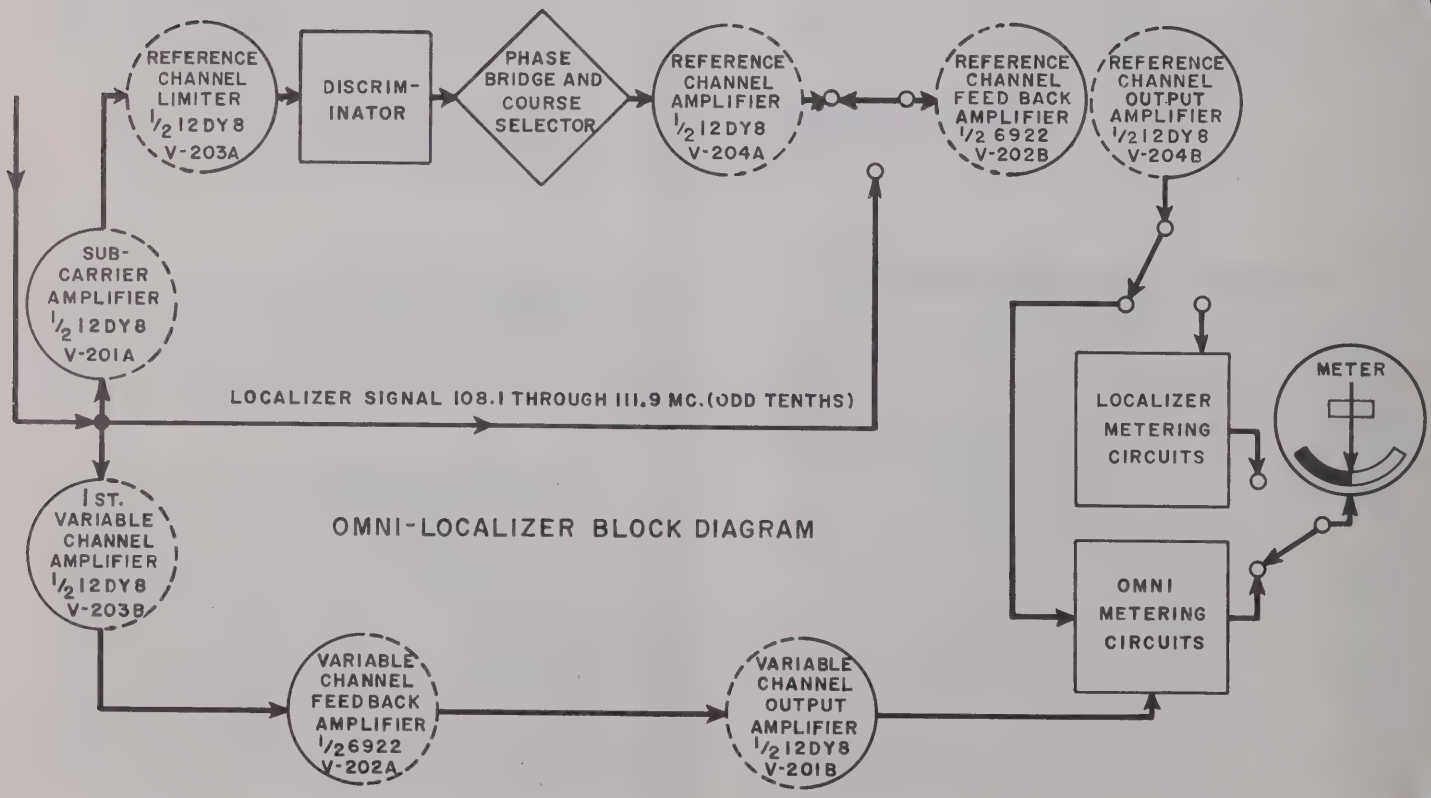
In any VHF radio installation, the type of antenna and its location is extremely important. Only with the proper antenna in the best location can the full range and accuracy of the VHF omni-range system be realized. In this system, a horizontally polarized V-type antenna is absolutely necessary. The quarter-wave whip, normally used for communications, is definitely not satisfactory, although it may appear to be when tried. While vertically polarized components of the omni signal are not normally radiated by the ground station, they are frequently produced by reflections. Therefore a vertical antenna may receive strong signals not coming directly from the ground station, giving very unreliable bearing information.

The antenna should be located well away from the engine(s) and propellor(s). Good reception is usually afforded by placing the antenna on top of the aircraft behind the cockpit or atop the vertical stabilizer. Other antennas and wires located within two feet of the omni antenna may cause weak reception from some directions and should be avoided.

The Narco type VRP-15A pedestal antenna may be mounted on the top of the aircraft to provide omni reception. A balun, cut to critical dimensions, is built into the mast of the antenna and should not be disturbed. The Narco type VRP-37 tail-mounting antenna is usually mounted atop the vertical stabilizer, with the rods pointing forward. When this antenna is used, a balun (normally included with the cable) must be installed between the antenna and the Mark VI antenna cable. All coaxial sheaths must be grounded at the point where the balun connects to the cable.



MARK VI. RECEIVER BLOCK DIAGRAM


REFERENCE CHANNEL LIMITER 1/2 12DY8 V-203A
DISCRIM-INATOR
PHASE BRIDGE AND COURSE SELECTOR
REFERENCE CHANNEL AMPLIFIER 1/2 12DY8 V-204A
REFERENCE CHANNEL FEED BACK AMPLIFIER 1/2 6922 V-202B
REFERENCE CHANNEL OUTPUT AMPLIFIER 1/2 12DY8 V-204B
SUB-CARRIER AMPLIFIER 1/2 12DY8 V-201A
LOCALIZER SIGNAL 108.1 THROUGH 111.9 MC. (ODD TENTHS)
LOCALIZER METERING CIRCUITS
METER
1ST. VARIABLE CHANNEL AMPLIFIER 1/2 12DY8 V-203B
OMNI METERING CIRCUITS
VARIABLE CHANNEL FEEDBACK AMPLIFIER 1/2 6922 V-202A
VARIABLE CHANNEL OUTPUT AMPLIFIER 1/2 12DY8 V-201B

OMNI-LOCALIZER BLOCK DIAGRAM

Figure 10

SECTION I V

CIRCUIT DESCRIPTION

A. Receiver

The receiver section of the Mark VI makes use of hybrid tubes in a dual-conversion, superheterodyne circuit, followed by a transistorized audio amplifier, eliminating the need for a power supply. The two converter oscillators are crystal-controlled; the high frequency oscillator uses nineteen crystals to provide the megacycle frequencies, while the low frequency oscillator uses ten crystals to provide the tenth-megacycle frequencies. At the detector the amplified and converted signal is split into two sections: audio intelligence, limited in a series-shunt type, peak noise limiter and then amplified in the transistorized audio amplifier; omni and localizer intelligence (without voice or code identification), which is passed to the omni section of the unit.

Initial RF signal separation is made, as the signal enters the receiver, by the first of three RF tuned circuits. These are gang-tuned in steps of one megacycle, with a one megacycle bandpass, by printed circuit inductors. Coupled to the grid, the RF signal is amplified by V-101, the 12DZ6 RF amplifier. The plate of V-101 is coupled to the second RF tuned circuit, where further signal separation takes place. AVC voltage is applied to the grid of V-101.

The amplified RF energy is further selected by the tuned grid circuit of V-102, a 12DZ6 first converter. In this stage, conversion energy from the high frequency oscillator is injected on the low side of the RF signal at the cathode, mixing with the RF energy to produce the difference frequency, selected in the tuned plate circuit, the primary circuit of T-101.

High frequency conversion energy is supplied to the first converter from the tuned plate circuit of the high frequency oscillator, V-103A and B, a 6922 type dual-triode. This butler-type oscillator uses series-resonant fifth overtone crystals coupled between the cathodes, to crystal control the oscillator. Nineteen crystals (XT-101 through XT-119) are used, in steps of one megacycle, from 82.55 through 100.55 Mc. V-103A acts as a grounded grid amplifier whose plate circuit is coupled to the grid of V-103B. Energy from this cathode-follower type circuit is returned to V-103A through the crystal. maintaining oscillation at the crystal frequency.

The high frequency IF energy from V-102, having a center frequency of approximately 25.9 Mc with a one megacycle bandpass, is coupled, through T-101, to the grid of V-104, the high frequency IF amplifier. This energy is amplified and fed through T-102, to the grid of the second converter, V-105. AVC voltage is applied at the grid of V-104.

In the second converter, conversion energy from the low frequency oscillator, introduced on the high side of the IF signal at the screen grid, mixes with the HF IF signal to produce a low frequency IF signal. This 7 Mc. signal is selected by the first of four tuned IF stages.

Low frequency conversion energy is generated in V-106, the low frequency oscillator. This pentode oscillator employs ten third-harmonic crystals (XT-120 through XT-129) in steps of 0.1 MC., from 32.45 through 33.35 Mc. From the broad-banded tuned plate circuit of this crystal-controlled oscillator, the conversion energy is applied directly to the screen grid of V-105.

Three low frequency IF amplifiers provide the necessary overall band-pass and amplify the 7 Mc IF energy from V-105. The first two of these employ 12EZ6 pentodes, V-107 and V-108. The signal is fed to the grid of V-107 from the secondary of T-103, amplified, taken from the plate and coupled through T-104 to the grid of V-108, where it is further amplified, taken from the plate of V-108 and coupled to the grid of V-109 by the third LF IF transformer, T-105. AVC voltage is applied to the grid of both amplifiers. The third LF IF stage, V-109, 12EK6 provides the final amplification of the 7 Mc IF signal for transfer to the detector-AVC stage, V-110A, a 12J8, with T-106 coupling together the two stages.

One diode of V-110A is used as a high-level diode detector, the detected output of which is developed across the diode load resistor. While the audio signal is passed through the noise limiter, the detected omni signal is taken from the diode load and fed directly to the omni amplifier circuits. AVC, developed across the load resistor of the second diode section, is delayed by a positive fixed bias applied at the cathode, and is applied to the RF amplifier, the HF IF amplifier, and the first and second LF IF stages through isolating resistors. The time constant of the AVC is controlled by the channel selector, (switching C-147) since the omni channels require a longer time constant for their accurate bearings than the communication channels, which

must follow rapidly the variations in signal. On omni channels, additional capacity is shunted across the AVC line to provide this longer time constant.

From the detector, the audio communications signal passes through the peak noise limiter, V-111, a 6AL5. Comprised of two diodes in a series and shunt-type, peak limiter, this stage clips high level noise of ignition and atmospheric interference, as well as extreme audio peaks. Audio volume level is adjusted by the volume control potentiometer located between the noise limiter output and the grid of the cathode follower, V-110B. The high-impedance audio signals present at the grid are transformed into low-impedance audio at the cathode of this stage to feed the transistorized audio amplifier.

Low level audio is coupled to the base of Q-101, the audio driver of the transistorized audio amplifier. A class A audio amplifier, Q-101 functions as the driver for the push-pull audio output stage. The operating level of this stage is established in the base-emitter circuit, with the output signal taken from the collector and applied to the primary of T-107. This transformer provides a balanced input for Q-102 and Q-103, the audio output transistors. With the balanced signal applied to the bases, Q-102 and Q-103 act as a Class B push-pull audio amplifier in a common-collector circuit. Reverse bias is developed by a series-shunt resistor network between the bases and emitters in order to establish the operating point of the Class B stage (no conduction under no signal condition). The collector load impedance is such that the stage will continue to amplify until it reaches its four watt output level and then clip or limit at higher levels.

The secondary of T-108 supplies the operating voltage to drive headphones and speaker. S-112 removes any loading by the Mark VI on a common speaker buss when the set is turned off.

B. Omni

The received signal is transmitted from the ground station as one continuous VHF carrier wave with three simultaneous, but non-interfering, amplitude modulations. These are:

1. Voice modulation—(35% maximum modulation) 200 to 2500 cycles.
2. Reference phase signal—(30% modulation) 9960 cycles sub-carrier, frequency modulated with a deviation of ± 480 cycles at a 30 cycle rate. This is a fixed phase 30 cycle modulation.
3. Variable phase signal — (30% modulation) 30 cycle AM, produced by rotating effectively a limacon antenna pattern 30 times per second at the station.

The variable phase signal is a 30 cycle sine wave modulation whose phase angle relative to the 30 cycle FM on the 9960 cycle sub-carrier depends on the bearing of the aircraft receiving antenna to the station. The station is adjusted so that the variable phase signal is "in phase" with the reference phase at a bearing due magnetic north (0° mag.) from the station. Thus the receiver omni output contains the above three separate and distinct audio components which are mixed together in simple addition.

It is the purpose of the Mark VI omni section to reject the voice modulation, separate the other two components, and indicate, by means of a course selector and meter, the relative phase angle between the variable phase signal and the reference phase signal, as received, thus indicating the bearing to or from the station.

The omni signal is introduced from the detector output of the receiver into the omni section on the grids of V-201A, Sub-carrier Amplifier and V-203B, 1st Variable Channel Amplifier. The amplified 30 cycle AM component passes into the variable channel from V-203B and the 9960 cycle sub-carrier with its 30 cycle FM passes into the reference channel.

REFERENCE CHANNEL

The frequency modulated 9960 cycle component of the signal from V-201A is passed through a two section RC filter to the grid of V-203A, the reference channel limiter. This high-pass filter is designed to attenuate any 30 cycle (or multiple of 30 cycle) component, preventing its introduction into the reference channel. The reference channel limiter functions as a 9960 cycle amplifier, feeding its signal to the dual diode limiter (clipper) and then to the primary of the discriminator transformer. The two diodes CR-201 and CR-202 are biased so that CR-201 clips the negative peaks and CR-202 clips the positive peaks of the signal, substantially reducing any amplitude modulation on the 9960 cycle subcarrier caused by residual variable channel signal, propellor modulation, etc., and presenting a relatively clean FM signal to the discriminator.

The output of the discriminator appears across the diode load resistors, fed by discriminator diodes CR-203 and CR-204. This output is comprised of two 30 cycle signals, equal in amplitude and 180° out of phase (the phase angles being 90° and 270°), balancing to ground provided by a pair of closely matched resistors, which provide a center tap to ground. When applied to opposite terminals of the phase bridge, these signals establish two legs (90° and 270°) of the bridge, the other two (0° and 180°) established by phase shifting RC networks. With every phase angle at a known point on the linear phase bridge (course selector), the course selector arm is used to select any desired phase angle (bearing) between 0° and 360°. A 10:1 loss in voltage occurs across the phase bridge, and is regained by amplifying the 30 cycle signal of the desired phase in V-203B and V-204A, the first and second reference channel amplifiers.

This signal is applied to the reference channel feedback amplifier, V-202B. Output from this stage drives the reference channel output amplifier, V-204B, providing the power necessary to drive the metering circuits. The output transformer of this channel provides two independent signals; the TO-FROM signal, shifted 90° in phase and applied to the TO-FROM metering circuit, and the LEFT-RIGHT signal, applied to the LEFT-RIGHT metering circuit. In addition, the latter winding provides negative feedback to the cathode of V-202B to reduce amplitude distortion over the variations in primary input voltage and signal level that this amplifier operates.

VARIABLE PHASE CHANNEL

The 30 cycle AM variable phase component of the omni signal is passed through an RC type, L-section, low-pass filter phase shifter to the grid of the variable channel feedback amplifier, V-202A. The low-pass filter attenuates the 9960 cycle, audio and 60 cycle components present at this point. A 30 cycle phase shift is also introduced at this point, which, when added to the other incidental phase shifts present in Mark VI, provides a constant 90° shift between reference and variable channel outputs when the L-R meter reads zero. The "zero adjust" potentiometer, R-204, is used to make the final vernier adjustment of this phase shift.

Amplified in V-202A, the signal is passed to V-201B, the variable channel output amplifier, where it is further amplified and used to drive the metering circuits. Feedback from the secondary of the variable channel output transformer is applied to the cathode of V-202A, again to reduce amplitude distortions in the two amplifier stages.

OMNI METERING CIRCUIT

The TO-FROM and LEFT-RIGHT metering circuits are essentially AC wattmeters, in which, for small deviations from 90° and 270° phase angles the meter deflection is approximately proportional to the deviation of the phase angle between the reference and variable channel 30 cycle outputs.

In the LEFT-RIGHT circuit, CR-205A and B are used to rectify the output voltages from the reference and variable channels. The voltages developed across their load resistors are used to drive the meter movement. The resultant voltage will be zero (meter reads zero) when no voltage is applied from one channel or the other or if there is a 90° phase relationship between the two. In this manner, any deviation from 90° or 270° (reciprocal course) will cause one diode to conduct more than the other, in turn developing a voltage that will cause the meter needle to swing.

The TO-FROM circuit operates in much the same manner, except that an RC phase shift network in the reference channel transformer secondary shifts the output voltage 90°. This causes the TO-FROM flag to deflect to its maximum degree when the LEFT-RIGHT meter is centered and in an amount either TO or FROM depending on whether the two channels are 90° or 270° apart in phase relationship.

Both meter movements are damped by the large electrolytic capacitors C-233 and C-234, one across each meter.

LOCALIZER

When the receiver is channelled to a localizer frequency, relay K-201 automatically switches function to remove the omni circuitry and allow V-202B and V-204B to be used as the localizer amplifiers. The primary winding of T-202, the omni reference channel output transformer primary, is shorted, T-203 is substituted and the meter function is switched to complete the transition from omni to localizer.

The localizer signal is applied on the grid of V-202B, the reference channel output amplifier. The amplified signal is passed to the reference channel output amplifier where sufficient amplification takes place to drive the localizer metering circuits.

LOCALIZER METERING

The amplified 90 and 150 cycle components of the localizer signal are separated by T-204, C-232, resonant at 90 cycles, and T-205, C-231, resonant at 150 cycles. Diodes CR-207A and B rectify the two signals; when "on course," there is no difference in signal amplitude, whereas, "off course," there is a difference in amplitude between the two signals, causing one diode to conduct more than the other. These voltages appear across the load resistors, with the difference reflected across the meter, causing it to swing left or right. The TO-FROM meter will deflect toward TO in proportion to the strength of the localizer signal.

SECTION V

MAINTENANCE

A. Mechanical Maintenance

SHIELDED SECTIONS

Access to the HFO section of the receiver may be accomplished by unsoldering the shield over this section and removing the shield. All leads in this section are critically dressed and should be replaced in their proper positions before the shield is replaced. Be sure the shield is soldered to the chassis after replacement.

RECEIVER CHANNEL SELECTOR SHAFT ALIGNMENT

With the receiver channel selector set to the 108.0 MC position, the key-way of each switch wafer must face to the right (looking at the front of the unit) and the flat surfaces of the shafts must be in a vertical position.
The KC switch shaft detent should be against the stop in a counter-clockwise position when the channel selector is in the .0 KC position. This detent should be tightened on the shaft in a position that will give a reasonable turning tension. The stators of all switch wafers may be adjusted for proper wiper contact timing.

OMNI SECTION MAINTENANCE

The replacement of certain inaccessible components in the omni section of the Mark VI requires the dismantling of the unit. These components may best be replaced by the procedure shown below.

1. Remove the four screws holding trim panel.
2. Loosen the four set screws holding the volume control and KC channel selector knobs and remove knobs.
3. Loosen the MC channel selector knob and the KC dial.
4. Remove the trim panel.

At this point, the omni course selector, lamps, meter, and channel selector shafts could be removed should replacement be necessary.

5. Remove screws holding omni side wall to center spacer, rear and front panel. Remove side wall.
6. Omni printed circuit board may now be pulled away from inner side wall (use caution) for service. Normal service does not require this dismantling.
7. Remove screws holding inner omni side wall to rear panel and pull omni section (gently) away from receiver section.

The transformers on the side wall may be removed by bending out the tabs on the back of the wall and pulling the transformer out. Replacement should be made by inserting the tabs through the holes in the wall and bending them down against the wall.

After replacement of any defective parts the unit may be re-assembled in the reverse of the order shown above.

B. Printed Circuit Maintenance

Narco equipment has utilized printed circuitry for some time. Out of necessity, procedures have been developed for the repair and replacement of printed circuit components. Utmost care must be taken in this type of repair to prevent the printed wiring from being damaged. The following methods have proven to be satisfactory and should be used in the servicing of the omni circuitry.

TOOLS REQUIRED FOR REPAIR

1. LOW WATTAGE (40 watts) soldering iron, with a small chisel tip.
2. Needle nose pliers.
3. Small wire clippers.
4. Small stiff bristled brush (paste applicator).
5. Scribe or other sharp pointed instrument.

CAUTION: NEVER place the soldering iron directly on the printed circuit if it can be avoided. EXCESSIVE HEAT will raise the circuit from the board.

REPLACEMENT OF RESISTORS AND SMALL CAPACITORS

1. Clip the leads and remove the component from the board.
2. Using the chisel tip of the 40 watt soldering iron, lift the remaining ends of the component from the board.
3. Use the tip of the iron to open the holes in the board, drawing the solder away from the holes.
4. Bend the leads of the replacement component and fit them through the holes (observing polarity, if any).
5. Bend over the leads and clip them short.
6. Resolder.

REPLACEMENT OF TUBE SOCKETS

1. Using the pliers or clippers, break the socket

away from its pins.
2. With as little applied heat as possible, use the soldering iron to soften the solder joint enough to pull each pin out of the board with pliers.
3. Clear the holes and insert the new socket, orienting the space between pins 9 and 1 correctly.
4. Resolder.

REPLACEMENT OF LARGE CAPACITORS, TRIMPOTS AND DISCRIMINATOR TRANSFORMER

1. Heat each joint enough to soften the solder and using the stiff brush, brush away the solder. Do only one joint at a time or only as large an area as will require a minimum of heat.
2. GENTLY pull the defective part from the board when all joints have been cleaned.
3. Clear the holes and insert the replacement component. (Orient correctly.)
4. Resolder.

This brushing method may be used to remove any component where it is undesirable or impossible to clip the leads.

C. Transistor Maintenance

The audio transistors located on the rear panel of the unit may be replaced by removing the screws from each end of the transistor and carefully pulling the transistor off of the panel. These transistors are insulated from the chassis by thin mica insulators. Be sure that the mica is not damaged when the old transistor is removed or the new transistor is installed. These transistors must be replaced by units obtained from the factory and must be identified by the color dot as well as the part number since the amplification characteristics of each dot class are critical. WHEN OPERATING THE UNIT, DO NOT SHORT THE CASES OF THESE TRANSISTORS TO THE CASE.

When checking the audio transistors, it is necessary to disconnect or remove the transistor from the panel. A shorted condition may be checked by using a Simpson model 260 ohmmeter. Place the negative lead of the meter, using the "R x 1" scale, on the collector (case) and the positive lead on the emitter. (E). A "good" transistor will measure 200-500 or more, depending on its condition and the characteristics of the ohmmeter used. SHORTED TRANSISTORS WILL MEASURE 2 OHMS OR LESS.

WARNING

Transistors can be damaged or ruined if subjected to excessive voltage or current. Therefore, avoid the application of surges or high DC input to the Mark VI, such as the no-load voltage from an unregulated DC bench power supply. Also avoid short-circuiting the cases of the transistors to the chassis while the unit is operating. Excessive current or voltage may result in a condition known as "punch through," where the germanium barrier in the transistor shorts. Such failures may not occur at the moment of shorting, but at some later time, as each short weakens the transistor.

NOTE: Do not operate the Mark VI in an aircraft while the aircraft electrical system is connected to an auxiliary power unit.

BENCH TEST POWER SUPPLY

DC Power Supplies operating from the 115 volt AC line will require a suitable load resistor on the DC output terminals to improve the regulation and prevent voltage surges. The value and wattage rating of the resistor required for use with a particular supply will depend on the maximum current rating of the supply. A resistor of 3 ohms, 300 watts, connected across the DC source will draw 4.6 amps at 13.75 volts, or 9.2 amps at 27.5 volts; this should be sufficient constant load to provide good voltage regulation. We suggest connecting three 1 ohm, 100 watt resistors in series across the output terminals of the bench power source.
While the primary voltage source of the aircraft is sufficiently pure DC voltage for reliable operation of the Mark VI, some bench test power units have excessive AC ripple on their DC output. Omni compensation of the Mark VI becomes difficult and even unreliable when this AC ripple exceeds 0.1 VAC.

Should the AC ripple on the DC output of the supply exceed 0.1 VAC, we recommend the use of a filter to reduce this level. A battery of the same voltage and with sufficient current capacity connected across the output terminals of the supply will provide an excellent filter; or, the filter shown below will reduce the AC ripple of most supplies to an acceptable level.

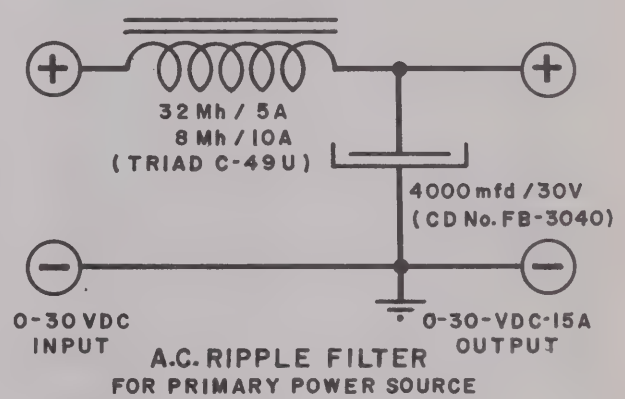


Figure 11

We recommend the ELECTRO model NFB DC Power Supply for bench testing and compensating the Mark VI, as it has sufficient regulation and the low AC ripple necessary for satisfactory bench operation without a regulating load or filter. (Before the supply is turned on, the output control should be turned all the way down; after the supply is turned on, the output control may be increased to the desired voltage. This will prevent starting surges and the accidental application of the wrong voltage.)

E. Performance Check

SECTION	PROCEDURE	TEST SIGNAL	NORMAL INDICATION
1. Overall Check	Connect VHF Sig. Gen. to MK VI antenna connector. Connect wattmeter to spkr. leads (3 ohms).	10 uv. (108.0 to 126.9 Mc)	4 w.
2. Low Freq.	With AC VTVM connected to junction of R-116 and R-117, disconnect C-118 from T-102, tack solder .01 mfd. cap. from center well of V-105 to pin 6 of V-105, connect low frequency signal generator to C-118. Remove .01 mfd capacitor after test.	7 MC, 25 uv.	0.20 VAC
3. Low Freq. Conversion Gain	Connect HF Sig. Gen. (25-27 Mc Range) to C-118; connect AC VTVM to junction of R-116 & R-117. Reconnect C-118 after test.	Generator set 26.35 Mc, 175 uv; Receiver KC dial .9 pos. Generator set 25.45 MC, 175 uv; Receiver KC dial .0 pos.	0.20 VAC
4. Overall IF Gain	Connect AC VTVM to junction R-116 & R-117. Disconnect C-110 from pin 1 of V-102 leaving R-105 in circuit. Connect HF Sig. Gen. (25-26MC) to pin 1 V-102, through .001 mfd cap. Remove after test.	Generator set 25.45 MC, 5 uv; Rec. KC dial .0 pos. Generator set 26.35 MC, 5 uv; Rec. KC dial .9 pos.	0.20 VAC .50 pos. should be no more than 6 db down
5. High Freq. Osc.	Take from alignment procedure.		
6. High Freq. Conv. Gain	Connect AC VTVM to junction R-116 & R-117. Disconnect C-110 from pin 1 of V-102, leaving R-105 in circuit. Connect HF Sig. Gen. (108-126MC) to Pin 1 of V-102 through .001 mfd cap. Remove after test.	Generator set 108-126.9 MC Recvr. set 108-126.9 MC, 25 uv. input.	0.20 VAC
7. RF Amp.	Connect VHF Sig. Gen. to MK VI ant. conn.; connect AC VTVM to junction of R-116 & R-117.	Generator set (108.0-126.9 MC) 5-10 uv.	0.20 VAC
8. Audio	Connect VHF Sig. Gen. to ant. conn.; volume fully advanced; AC VTVM connected to pin 2 of V-110B	Generator set on Rec. Channel, output to give 0.20 VAC at R-116 & R-117.	0.02 - 0.035 VAC

D. Equipment Required for Electrical Maintenance

a. AC VTVM Ballantine model 300 or equivalent

b. Low frequency signal generator — General Radio model 1001A or equivalent.

c. High frequency signal generator — Hewlett Packard model 608D or equivalent.

d. Sweep generator — Kay Vari-Sweep or equivalent.

e. High input impedance VTVM — RCA Volt-ohmyst or equivalent.

f. Oscilloscope — Dumont model 401 or equivalent.

g. High input impedance detector — specially constructed; refer to Figure 11.

h. Audio Wattmeter—General Radio type 583-A or equivalent.

i. Headphones, low impedance (600 ohms).

j. Variable primary power source—Electro model NFB or equivalent.

k. Omni Simulator—Collins 479S-3 with Boonton 211-A or ARC H-14A.

l. For phase angle measurements—Narco model T-4 Filter Voltmeter.

F. Receiver Alignment

LOW FREQUENCY IF STAGES

1. Connect the AC VTVM to the junction of R-116 and R-117, the detector output.
2. Connect the vertical input of the oscilloscope to the same point to monitor the output. Set the horizontal sweep to INTERNAL.
3. Disconnect C-118 from T-102.
4. Tack solder a .01 mfd capacitor from center well of V-105 to pin 6 of V-105.
5. Connect the low frequency signal generator (set to 7 Mc) to C-118.
6. Tune the low frequency IF transformers, T-103, 104, 105, and 106 for maximum AC voltage. 25 uv. input should give approximately 0.20 VAC output.
7. Remove .01 mfd capacitor from pin 6 of V-105.

LOW FREQUENCY OSCILLATOR

1. Set receiver KC dial to .5 position.
2. Connect one end of 1 megohm resistor to pin 1 of V-106
3. Connect VTVM to 1 megohm resistor and use the negative 5 volt scale.
4. Tune L-115 maximum negative voltage. Voltage indication should be approximately —2.0 VDC.

LOW FREQUENCY IF CONVERSION GAIN

1. Connect the AC VTVM to the junction of R-116 and R-117.
2. Connect the high frequency signal generator (set to the 25-27 Mc range, 175 uv. output) to C-118.
3. Set the receiver KC dial to the .9 position.
4. Set signal generator to 26.35 Mc. Record indication from AC VTVM, this should be approximately 0.2 VAC.
5. Set the receiver KC dial to the .0 position.
6. Set the signal generator to 25.45 Mc. Record indication from AC VTVM; this should be approximately 0.20 VAC.

HIGH FREQUENCY IF STAGE

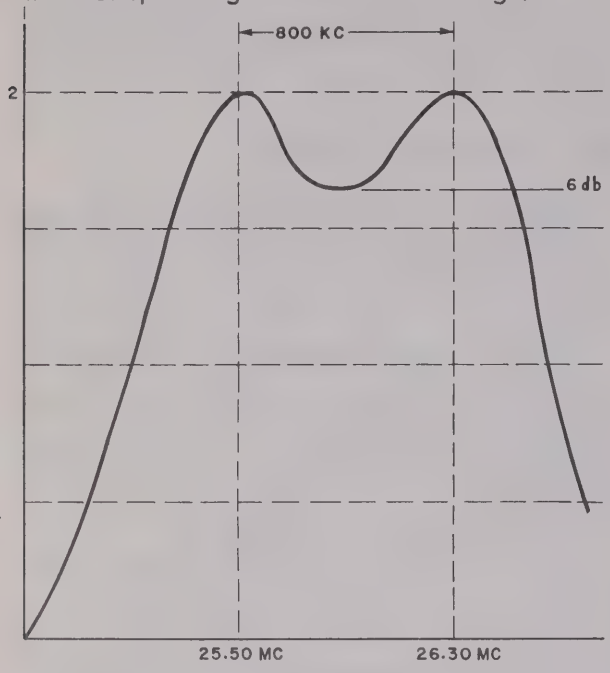
1. Reconnect C-118 to T-102.
2. Disconnect pin 5 of V-105 from T-103, and install the high input impedance detector (refer to Figure 11) as follows:
   Connect a 1.0 uhy choke to B-plus side of T-103.
   Connect 47 mmfd capacitor from detector to pin 5 of V-105.
   Connect the output of the detector to "Y" input of the oscilloscope.
   Connect the AC VTVM to the "Y" input of the scope.
   Ground detector to receiver chassis.
   Connect A-plus to pin 4 of TL-102.
   Connect detector B-plus to external 90V. source.
3. Connect .01 mfd capacitor from center well to pin 6 of V-105
4. Set scope horizontal sweep to "EXTERNAL."
5. Connect the sweep output of sweep generator (sweep frequency - 25.90 Mc) to the "X" input of the scope.
6. Disconnect C-110 from pin 1 of V-102, leaving R-105 in the circuit.
7. Connect RF output of sweep generator to pin 1 of V-102.
8. Tune the high frequency IF transformer, T-101 and T-102, for the frequency response in Figure 10. Loop couple signal from high frequency signal generator to pin 1 of V-102 in order to position the 25.50 and 26.30 Mc peaks.

HIGH FREQUENCY OSCILLATOR TUNING

1. Connect a 1 megohm isolation resistor to pin 7 of V-103.
2. Connect VTVM, set on negative 15 volt range, to the isolation resistor.
3. Set MC dial to 108 Mc position. Tune C-137 for maximum indication on volt meter.
4. Set Mc dial to 126 Mc position and repeat tuning procedure in step 3, this time tuning L-114.
5. Lower primary input voltage to approximately 10.5 VDC (12 V unit) or 21 VDC (27 V unit). Repeat steps 3 and 4 until no further interaction between C-137 and L-114 is noted. Then turn L-114 an additional ¼ turn CCW.
6. Index MC dial through all positions, making sure V-103 is oscillating on all channels.

If a channel is dead on the low end of the band, tune C-137 until oscillation occurs. Tune L-114 for channels on high end of band that do not oscillate.

NOTE: When not oscillating, —0.2 VDC can be observed at pin 2 of V-103; when oscillating, —4 to —5 VDC can be observed at pin 2 with set operating at normal line voltage.



H.F. — I.F RESPONSE CURVE

Figure 12

OVERALL IF GAIN

1. Connect AC VTVM to the junction of R-116 and R-117.
2. Disconnect C-110 from pin 1 of V-102, leaving R-105 in the circuit.
3. Connect the high frequency signal generator, using 5 uv. output in the 25 to 26 Mc range, to pin 1 of V-102, through a .001 mfd capacitor.
4. Set receiver KC dial to .0 position and tune the signal generator to 25.45 Mc. Record indication of the AC VTVM
5. Set receiver KC dial to .9 position and tune the signal generator to 26.35 MC. Record the indication of the AC VTVM.
6. The .0 indication and the .9 indication should be approximately equal at approximately 0.20 VAC. (with the .5 position no more than 6 db down). T-101 and T-102 may have to be retuned.

RECEIVER RF ALIGNMENT

1. Connect AC VTVM to the junction of R-116 and R-117.
2. Set HF signal generator on 108 to 126 Mc range, and connect the RF output to the receiver input. Use 5 uv. input.
3. Set receiver MC dial to the 126 position and KC dial to .5 position. Set signal generator to 126.50 Mc.
4. Tune L-111, 112 and 113 for maximum AC VTVM indication.
5. Set receiver MC dial to 108 position and KC dial to .5 position. Set signal generator to 108.50 Mc.
6. Tune C-102, 107, 109 for maximum AC VTVM indication.
7. Repeat steps 3, 4, 5 and 6 until no further increase in AC voltage can be obtained.
8. A level of 0.20 VAC should be obtained with an input of 5 to 10 uv. across the band 108.0 to 126.9 Mc.

G. Omni Alignment and Compensation

DISCRIMINATOR ALIGNMENT

The discriminator should be aligned with the aid of an AC VTVM and a simulated omni signal fed into the receiver antenna terminal. Proceed as follows:

1. Connect omni simulator to receiver antenna terminal. Set receiver and simulator to omni channel, using 500 uv. signal input.
2. Connect AC VTVM on pin 6 of V-204B (Reference Channel Output Amplifier); set on 10 V. scale.
3. Tune primary (bottom slug) and secondary (top slug) of discriminator for maximum AC volts output. Both slugs will peak, but the maximum output may not have been reached; therefore, vary the position of the slugs and re-peak until both maximum output and peak is achieved.

REFERENCE AND VARIABLE CHANNEL GAIN

1. Set the simulator and course selector dial to 270°.
2. Connect AC VTVM to pin 6 of V-204B; set on 10 V. scale.
3. The voltage at this point should be within ±10% of 3.7 VAC. If it is not, replace R-242 to produce this voltage level (resistor values should be between 10K and 270K ohms).
4. Connect AC VTVM to pin 6 of V-201B; set on 10 V. scale.
5. The voltage level at this point should be within ±10% of 3.4 VAC. If it is not, replace R-213 to produce this level (resistor values should be between 4700 and infinite ohms).

OMNI COMPENSATION

The omni circuits are carefully compensated at the factory and should not require subsequent compensation unless certain critical components have been replaced. The following plan of compensation should be followed completely and in the order given, should it become necessary to perform it. It is strongly recommended, however, that the compensation not be disturbed unless absolutely necessary.

Phase Zero (0°) and Phase Split Balance

The phase zero adjustment shifts the phase of the variable signal to compensate for accumulated component tolerance errors, which would cause a fixed error in the course reading. A fixed error is one that is independent of omni course. Small compensations are made by adjusting R-204, shown in Figure 18. This one adjustment permits compensation for most of the error that arises as a result of component drifts (held to a practical minimum) and changes in tube characteristics.

Phase inversion is established from the push-pull output of the discriminator, and adjustments in phase split are made here.

1. Use a 500 uv. signal from the omni simulator into the receiver; channel receiver and simulator to same signal and check for quality and level of receiver omni output signal.
2. Set the simulator to 270°.
   Set the course selector dial to 270°.
3. Reset R-204 to center the left-right needle.
4. Set the simulator to 90°.
   Set the course selector dial to 90°.
5. Observe the amount of needle deflection from center. Adjust the primary (bottom slug) of discriminator (T-201) to remove ½ (split the deflection) of the deflection.
6. Reset R-204 to center the left-right needle.
7. Set the simulator to 270°.
   Set the course selector dial to 270°.
8. Observe the needle deflection. If it is more than 1°, repeat steps 2 through 8 until no significant difference exists between 90° and 270°.

Rectifier Balance (Reciprocal Error)

The purpose of this compensation is to balance the two rectifier circuits, which form a part of the L-R metering circuit. Unbalance which arises from the manufacturing tolerances of these components will cause a reciprocal error in the bearing readings.

A reciprocal error is one which causes the two course selector readings for the L-R meter centering to differ by not exactly 180° (±2°). The need for re-compensating the rectifier balance is indicated by excessive reciprocal error when the test signal is reversed. This is not necessarily so when the course selector dial is shifted 180°, which could be a course error.

1. Set the simulator to 270°, using a 500 uv. signal on an omni channel.
   Set the course selector on 270°, then center the needle.
   Now set the simulator to 90°.
2. Observe the amount and direction of needle deflection (this being the reciprocal error).
3. Set the simulator to 90°.
   Set the course selector to 90°, then center the needle.
   Set the simulator to 270°.
4. Observe the amount and direction of needle deflection.
5. Shunt R-240 across R-239A or R-239B for the least reciprocal error at 90° and 270°.

Phase Quadrature

When the phase bridge is properly aligned, there is a quadrature relationship (90 degrees) at the cardinal points, 0°, 90°, 180°, 270°. Should there not be 90° between these points, they may be compensated for proper relationship.

Refer to "Rectifier Balance" and check 270° for any shift (re-compensating if necessary), before proceeding with "Phase Quadrature."

1. Set both simulator and course selector to 0°. Observe needle deflection.
2. Set both simulator and course selector to 180°. Observe needle deflection.
3. If both 0° and 180° are low by the same amount, or high by the same amount, shunt or replace C-222 to bring them into quadrature with 270° and 90°.
4. If quadrature does not exist, that is if 0° and 180° are not high by the same amount, adjust C-218 or C-219 by shunting or replacement for exact quadrature.

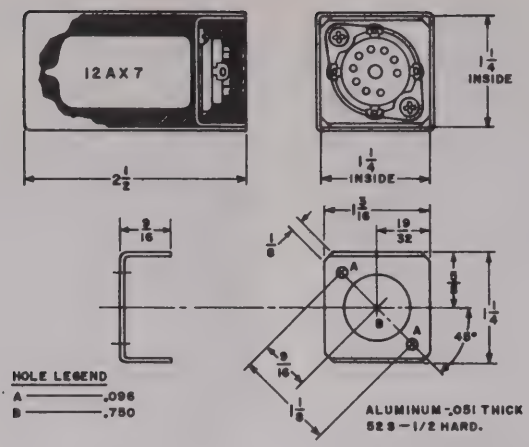
Finally, re-trace the COMPENSATION procedures to be sure nothing has changed. If there has been a change, use the compensation necessary to correct the condition. And again, check the unit.

ILS LOCALIZER BALANCE ADJUSTMENT

The balance adjustment (R-245) is set at the factory and should not be re-adjusted unless the proper equipment is available and the adjustment is definitely necessary.

1. Connect the ILS Localizer simulator to the receiver antenna terminal. Use a 500 uv. signal; set the simulator to "CENTER."
2. Channel the receiver to the signal (odd-tenth megacycles below 112.0 Mc).
3. Reset the balance control (R-245) to center the needle.

Check localizer operation on "blue," "center" and "yellow" courses.



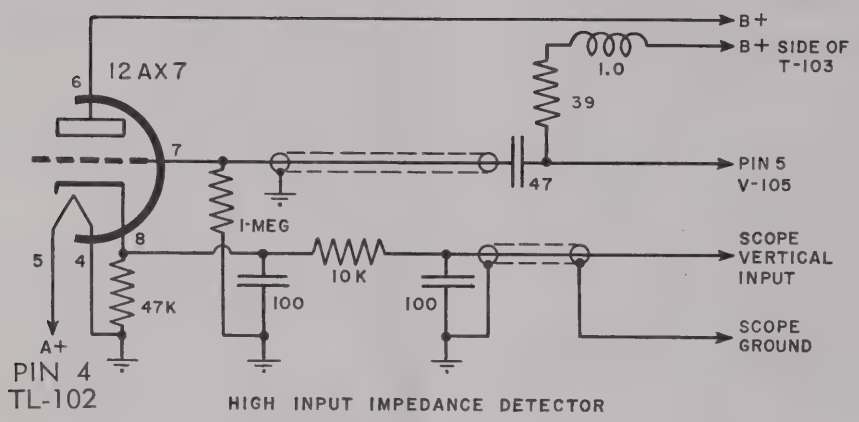


Figure 13

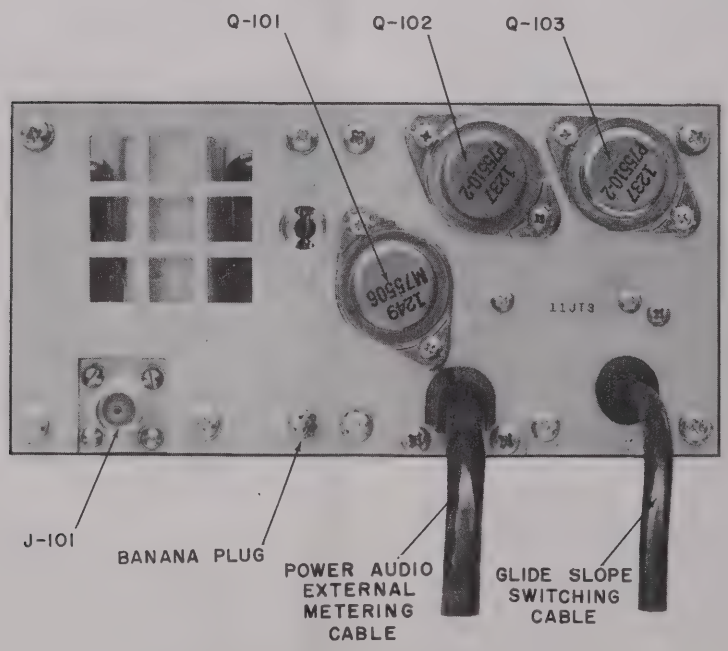


Figure 14 — REAR VIEW

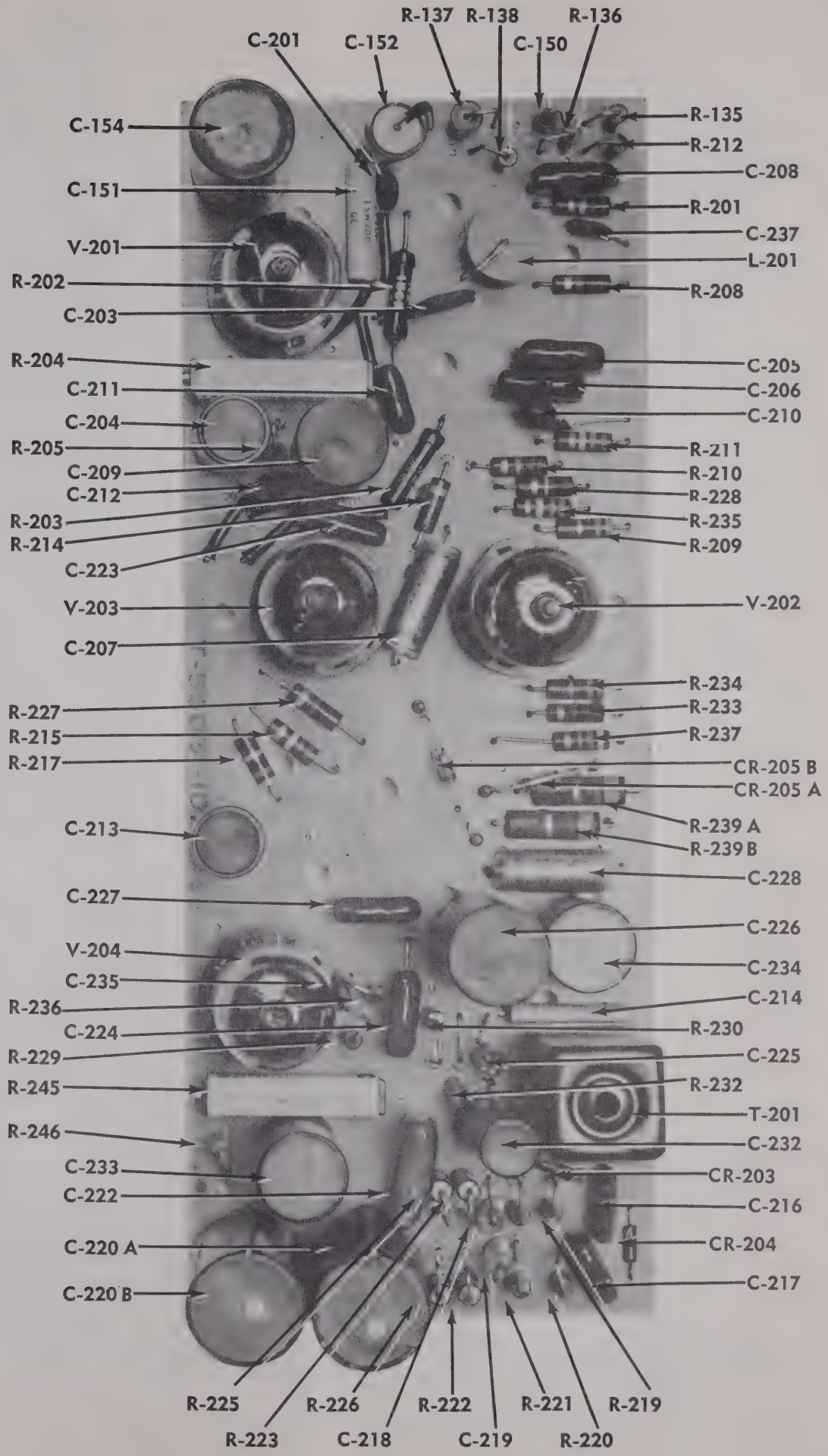


Figure 15 — OMNI PRINTED CIRCUIT BOARD

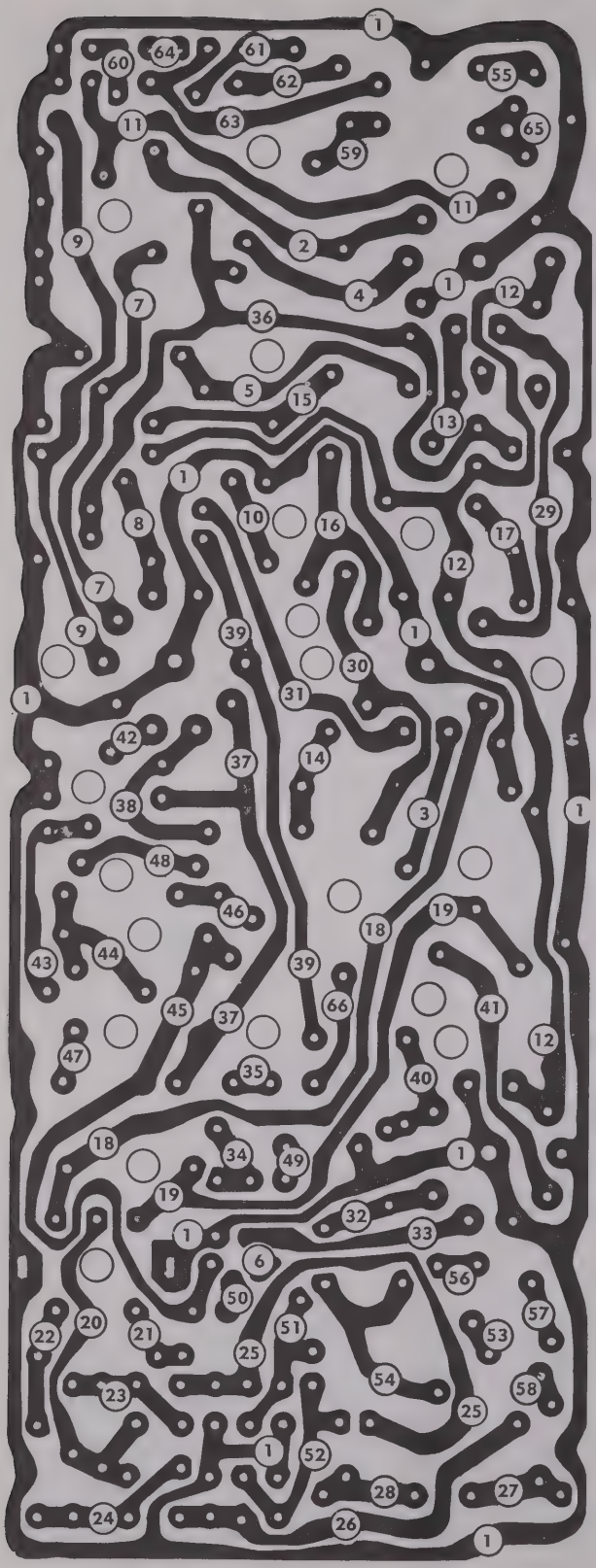


Figure 16

RECEIVER

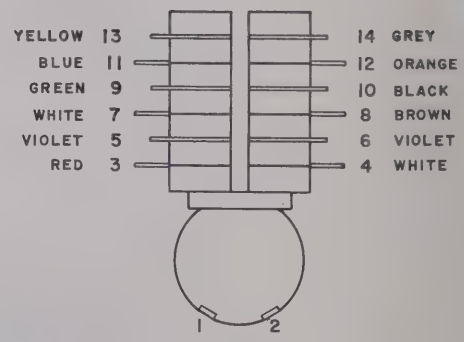
Voltage and resistance measurements are measured to ground. DC volts above the line and resistance below the line, shown in red.

All DC measurements made at 13.75 VDC input, at rated detector output of .22VAC, using a Hycon model 614 VTVM.

OMNI

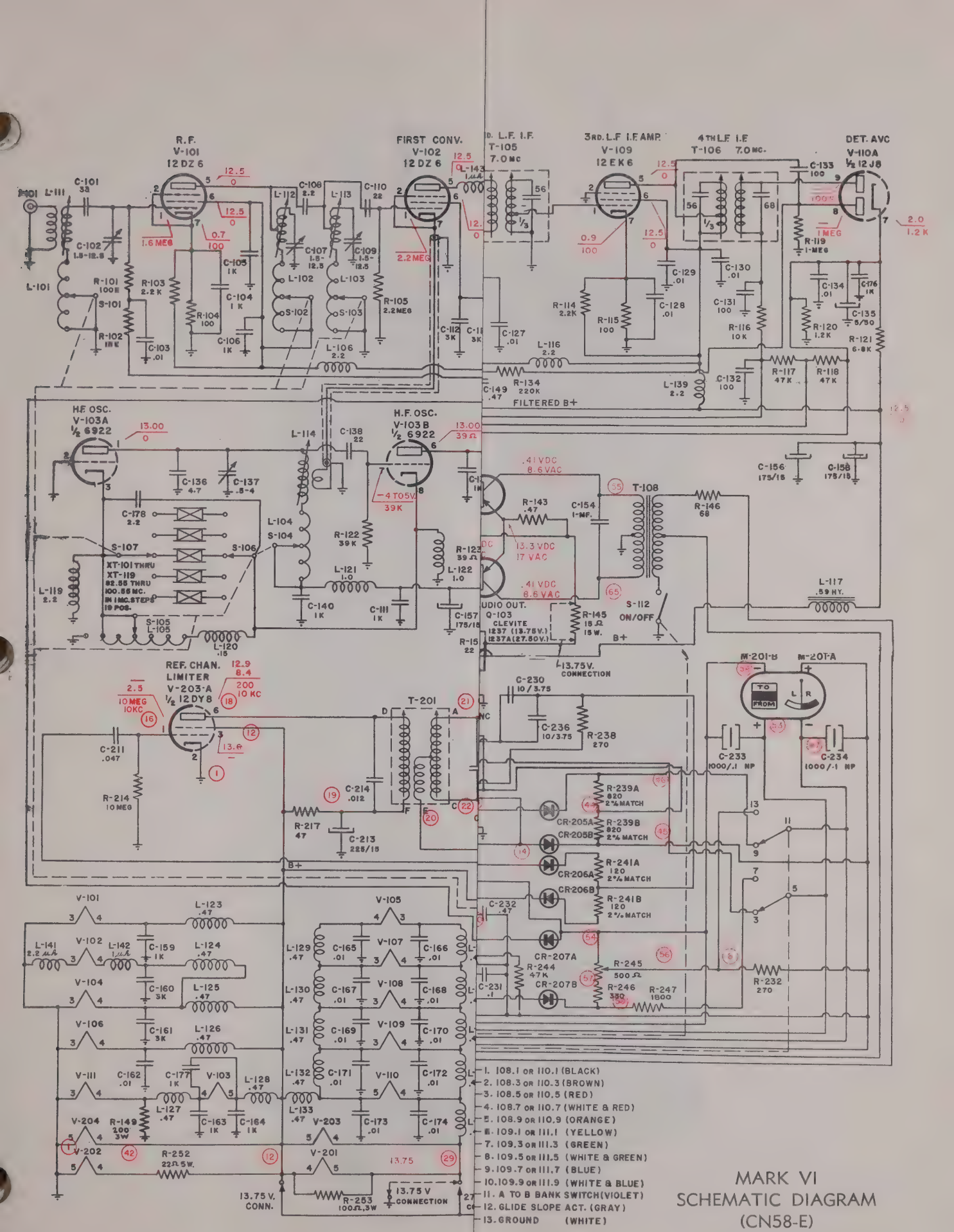
Voltage and resistance measurements are measured to ground. Above the line is AC volts; above AC volts is DC volts. Below the line is resistance; below resistance is phase angle; all in red.

All DC measurements made at 13.75 VDC input, with 500 uv. signal input, using a Hycon model 614 VTVM. All AC measurements made under same test conditions, using a Ballantine model 300 AC VTVM. Phase angles made with the Narco model T-4 Filter-voltmeter and a Collins Omni Simulator model 479-S3, using a reference of 270°.



LOCALIZER RELAY K-201
(CN58-B)

The diagram of the omni circuit board shown here shows the position of each circuit path by referring from the illustration to the numbers circled in red on the schematic diagram.



MARK VI
SCHEMATIC DIAGRAM
(CN58-E)
Figure 17

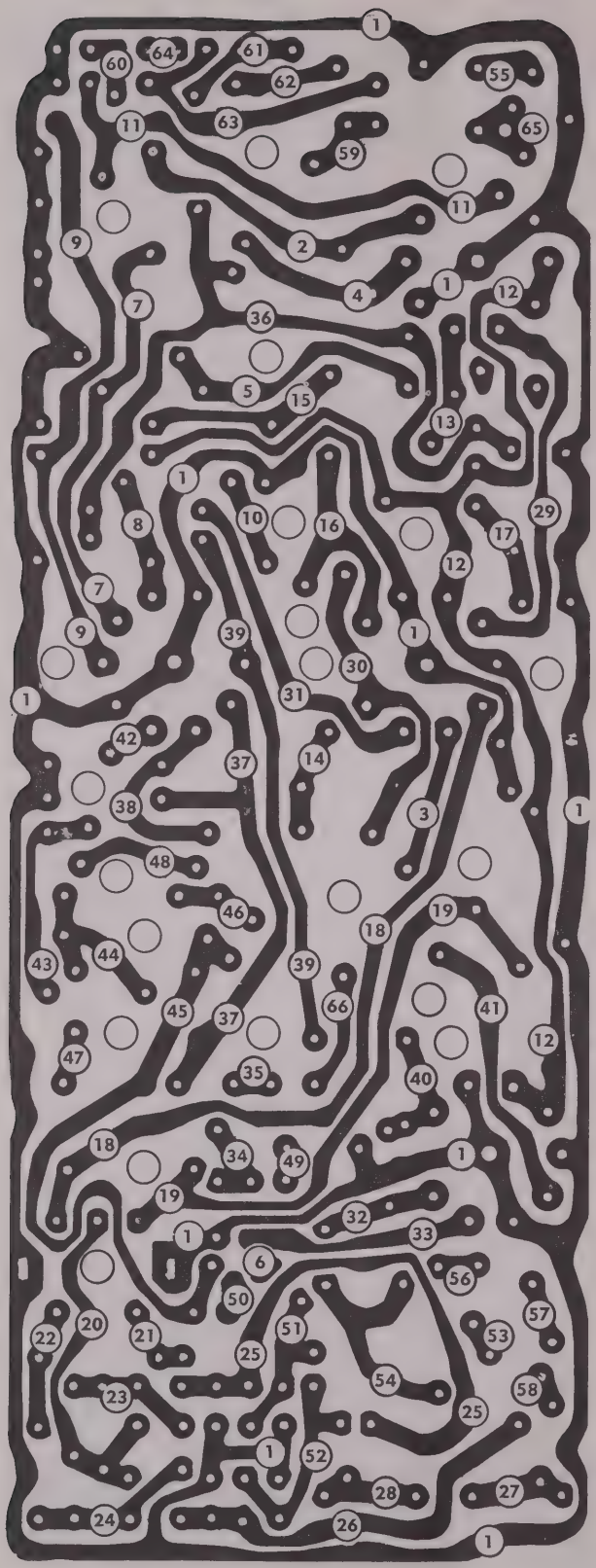


Figure 16

RECEIVER

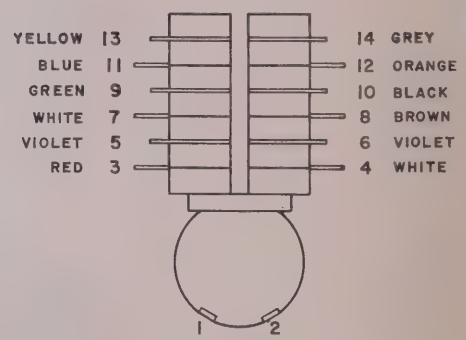
Voltage and resistance measurements are measured to ground. DC volts above the line and resistance below the line, shown in red.

All DC measurements made at 13.75 VDC input, at rated detector output of .22VAC, using a Hycon model 614 VTVM.

OMNI

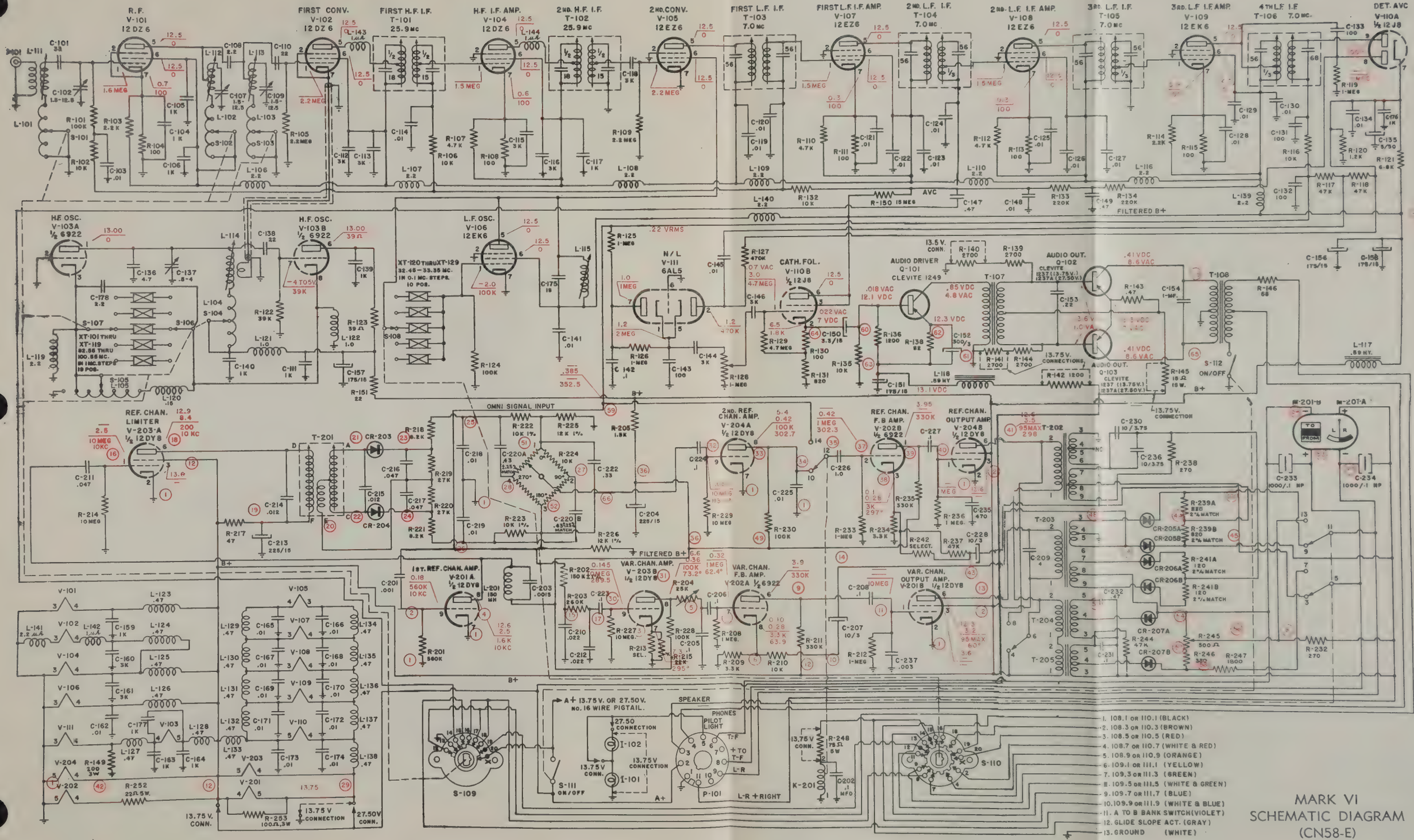
Voltage and resistance measurements are measured to ground. Above the line is AC volts; above AC volts is DC volts. Below the line is resistance; below resistance is phase angle; all in red.

All DC measurements made at 13.75 VDC input, with 500 uv. signal input, using a Hycon model 614 VTVM. All AC measurements made under same test conditions, using a Ballantine model 300 AC VTVM. Phase angles made with the Narco model T-4 Filter-voltmeter and a Collins Omni Simulator model 479-S3, using a reference of 270°.



LOCALIZER RELAY K-201
(CN58-B)

The diagram of the omni circuit board shown here shows the position of each circuit path by referring from the illustration to the numbers circled in red on the schematic diagram.


R.F. V-101 12DZ6
FIRST CONV. V-102 12DZ6
FIRST H.F. I.F. T-101 25.9MC
H.F. I.F. AMP. V-104 12DZ6
2ND. H.F. I.F. T-102 25.9MC
2ND. CONV. V-105 12EZ6
FIRST L.F. I.F. T-103 7.0MC
FIRST L.F. I.F. AMP. V-107 12EZ6
2ND. L.F. I.F. T-104 7.0MC
2ND. L.F. I.F. AMP. V-108 12EZ6
3RD. L.F. I.F. T-105 7.0MC
3RD. L.F. I.F. AMP. V-109 12EK6
4TH L.F. I.F. T-106 7.0MC.
DET. AVC V-110A 1/2 12J8
H.F. OSC. V-103A 1/2 6922
H.F. OSC. V-103B 1/2 6922
L.F. OSC. V-106 12EK6
N/L V-111 6AL5
CATH. FOL. V-110B 1/2 12J8
AUDIO DRIVER Q-101 CLEVITE 1249
AUDIO OUT. Q-102 CLEVITE 1237 (13.75V.) 1237A (27.50V.)
AUDIO OUT. Q-103 CLEVITE 1237 (13.75V.) 1237A (27.50V.)
REF. CHAN. LIMITER V-203-A 1/2 12DY8
1ST. REF. CHAN. AMP. V-201 A 1/2 12DY8
VAR. CHAN. AMP. V-203 B 1/2 12DY8
VAR. CHAN. F.B. AMP. V-202A 1/2 6922
REF. CHAN. F.B AMP. V-202B 1/2 6922
2ND. REF. CHAN. AMP. V-204A 1/2 12DY8
REF. CHAN. OUTPUT AMP. V-204B 1/2 12DY8
VAR. CHAN. OUTPUT AMP. V-201B 1/2 12DY8
FILTERED B+
B+
AVC
OMNI SIGNAL INPUT
A+ 13.75 V. OR 27.50 V. NO. 16 WIRE PIGTAIL.
SPEAKER
PHONES
PILOT LIGHT
S-109
S-110
S-111 ON/OFF
S-112 ON/OFF
P-101
K-201
T-201
T-202
T-203
T-204
T-205
T-107
T-108
13.75 V. CONNECTION
27.50 CONNECTION
L-R +RIGHT
1. 108.1 or 110.1 (BLACK)
2. 108.3 or 110.3 (BROWN)
3. 108.5 or 110.5 (RED)
4. 108.7 or 110.7 (WHITE & RED)
5. 108.9 or 110.9 (ORANGE)
6. 109.1 or 111.1 (YELLOW)
7. 109.3 or 111.3 (GREEN)
8. 109.5 or 111.5 (WHITE & GREEN)
9. 109.7 or 111.7 (BLUE)
10. 109.9 or 111.9 (WHITE & BLUE)
11. A TO B BANK SWITCH (VIOLET)
12. GLIDE SLOPE ACT. (GRAY)
13. GROUND (WHITE)

MARK VI
SCHEMATIC DIAGRAM
(CN58-E)
Figure 17

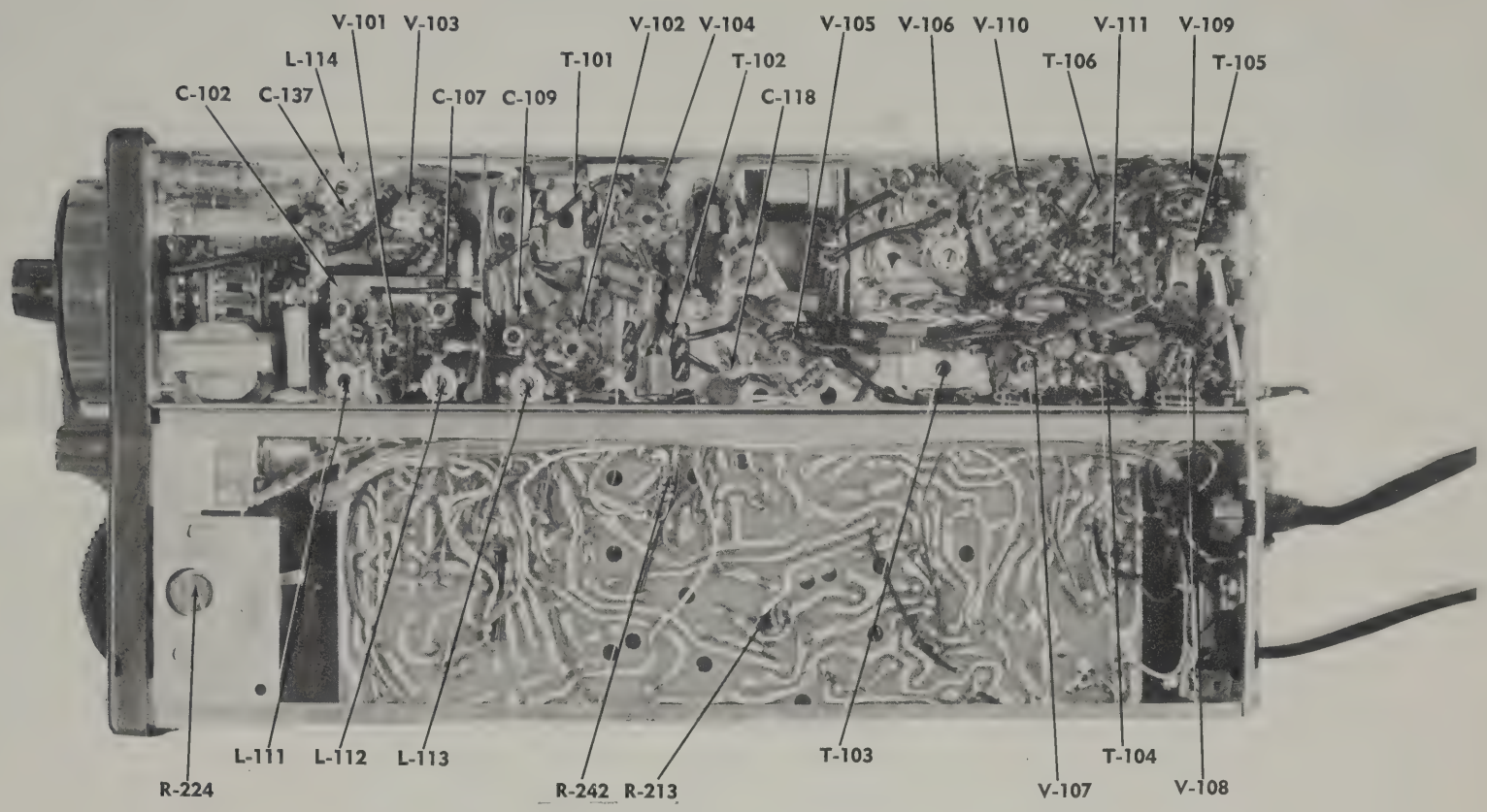


Figure 18 — BOTTOM VIEW

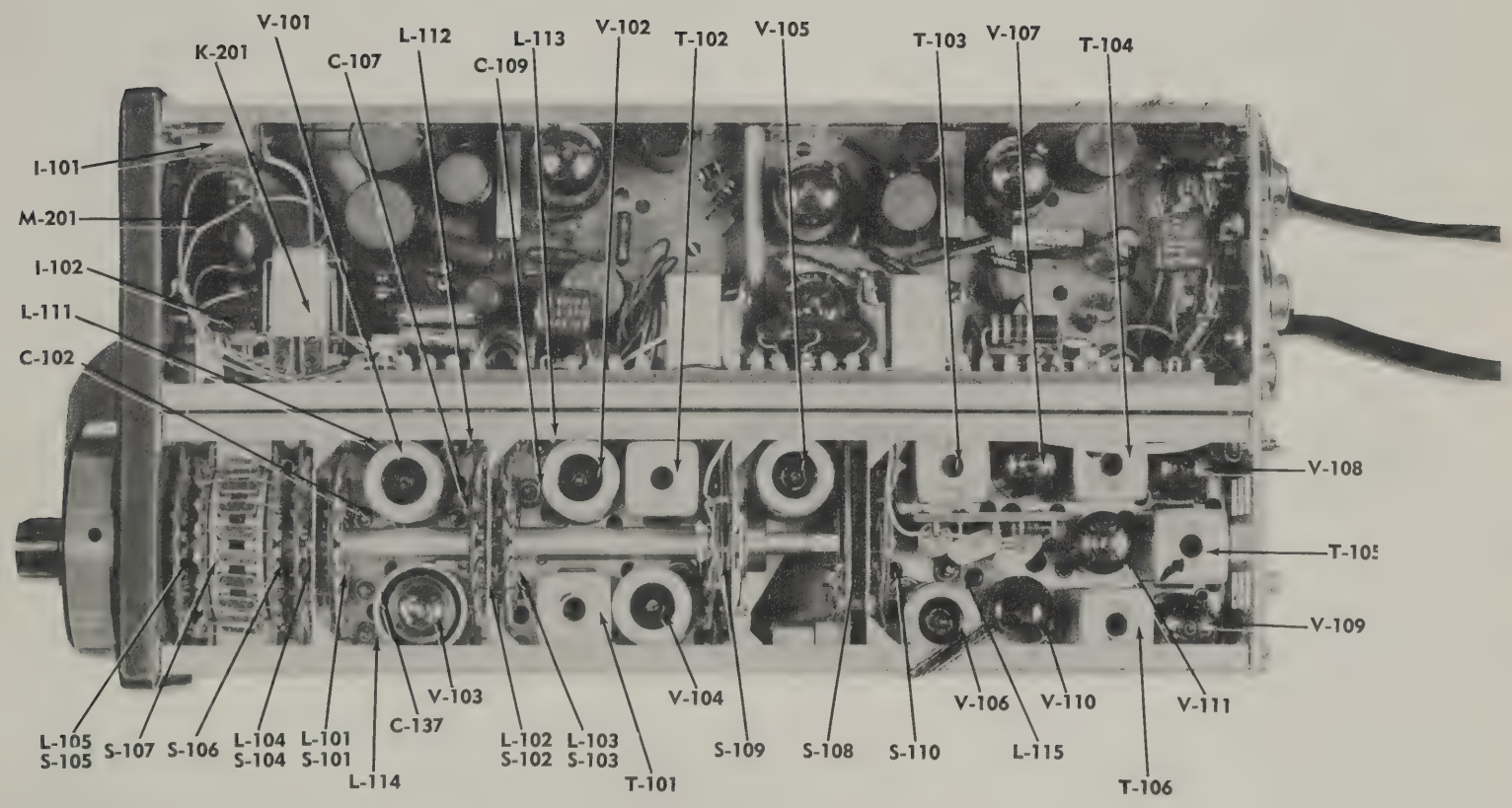


Figure 19 — TOP VIEW

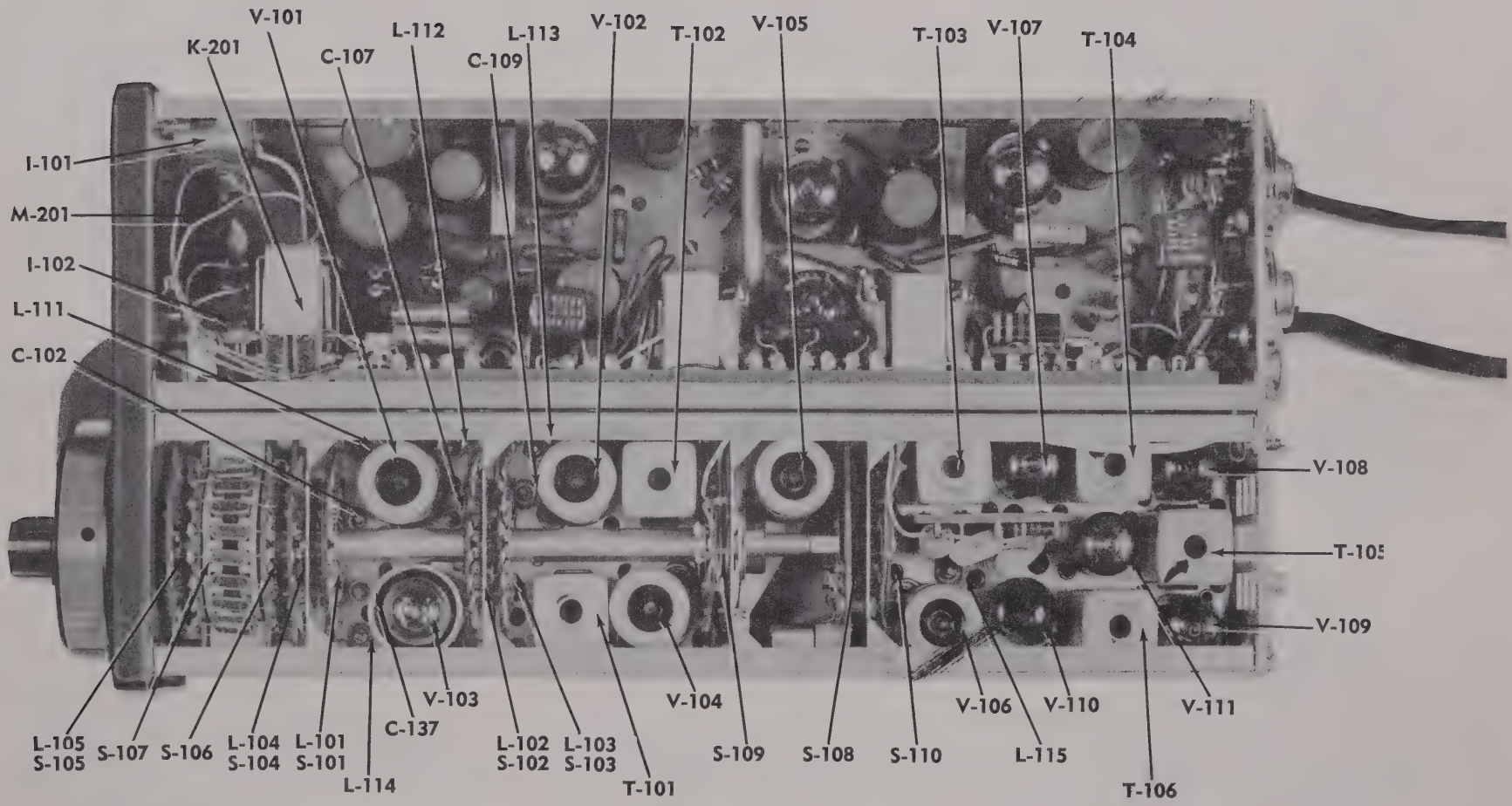


Figure 19 — TOP VIEW

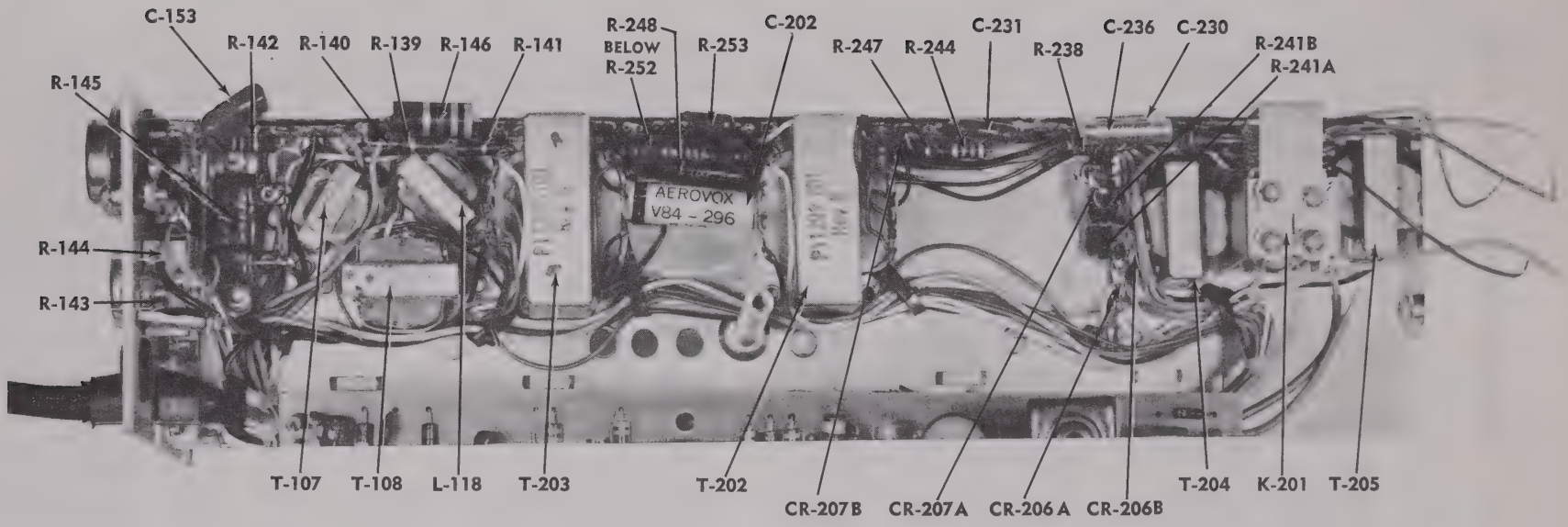


Figure 20 — OMNI SIDEWALL

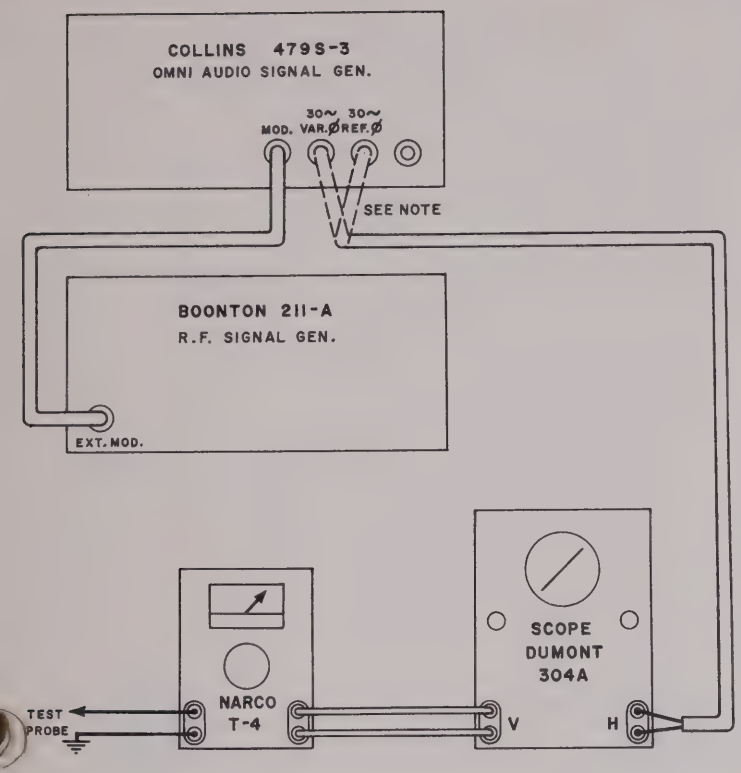
J. Replacement Parts List

C-101	21201-330	Capacitor, Ceramic, NPO	33 mmfd.
C-102, 107, 109	22019-4	Capacitor, Variable Plunger Type,	1.5 - 12.5 mmfd.
C-103, 114, 120, 124, 148, 225	23065-113	Capacitor, Mylar, 20%, 200V.,	.01 mfd.
C-104, 105, 106, 111, 117, 139, 140, 159, 163, 164, 176, 177, 201	21291-3	Capacitor, Ceramic Disc, 500 V.,	.001 mfd.
C-108, 178	2101-229	Capacitor, Ceramic Tubular, NPO,	2.2 mmfd.
C-110	21201-220	Capacitor, Ceramic Tubular, NPO,	22 mmfd.
C-112, 113, 115, 116, 118, 144, 146, 160, 161, 237	21291-4	Capacitor, Ceramic Disc, 500 V.,	.003 mfd.
C-119, 121, 122, 123, 125, 126, 127, 128, 129, 130, 134, 141, 145, 162, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174	21291-5	Capacitor, Ceramic Disc, 50 V.,	.01 mfd.
C-131, 132, 133, 143	21308-101	Capacitor, Tubular,	100 mmfd.
C-135	21524-49	Capacitor, Electrolytic, SREN, 50 V.,	5 mfd.
C-136	21201-479	Capacitor, Ceramic, NPO,	6.8 mmfd.
C-137	22023-3	Capacitor, Glass Trimmer,	.5 - 4.0 mmfd.
C-138	24504-27	Capacitor, Porcelain, NPO,	22 mmfd.
C-142, 202	23064-25	Capacitor, Mylar, 200 V.,	.1 mfd.
C-147, 149	23069-23	Capacitor, Mylar, 50 V.,	.47 mfd.
C-150	21548-2	Capacitor, Tantalum, 15 V.,	3.3 mfd.
C-151, 156, 157, 158	21550-1	Capacitor, Tantalum, 15 V.,	175 mfd.
C-152	21524-53	Capacitor, Electrolytic, 3 V.,	300 mfd.
C-153	23072-33	Capacitor, Dipped Mylar, 50 V.,	.22 mfd.
C-154, 226	23071-38	Capacitor, Mylar, 50 V.,	1 mfd.
C-175	21201-180	Capacitor, Ceramic Tubular, NPO,	18 mmfd.
C-203	21291-16	Capacitor, Ceramic Disc., 500 V.,	1500 mmfd.
C-204, 213	21551-1	Capacitor, Electrolytic, 15 V.,	225 mfd.
C-206, 208, 224, 231, 205, 223, 227	23072-125	Capacitor, Dipped Mylar, 50 V.,	1 mfd.
C-207, 228	21524-52	Capacitor, Electrolytic, 3 V.,	10 mfd.
C-209	23068-1	Capacitor, Metalized, 50 V.,	4 mfd.
C-210, 212	23065-317	Capacitor, Oval Mylar, 50 V.,	.022 mfd.
C-214, 215	23065-314	Capacitor, Oval Mylar, 50 V.,	0.12 mfd.
C-216, 217, 211A & B	23072-117	Capacitor, Dipped Mylar, 50 V.,	.047 mfd.
C-218, 219	23074-1		
C-220	23073-1	Capacitor, Polystyrene, 2%, 50 V.,	.43 mfd.
C-222	23072-37	Capacitor, Dipped Mylar, 50 V.,	.33 mfd.
C-230, 236	21549-1	Capacitor, Tantalum Foil, 3.75 V.,	10 mfd.
C-232	23071-84	Caacitor, Mylar, 50 V.,	.47 mfd.
C-233, 234	21547-3	Capacitor, Non Polarized, .1 V.,	500 mfd.
C-235	21291-2	Capacitor, Ceramic Disc, 500 V.,	470 mmfd.
CR-203, 204	75013-1	Diode, Silicon	
CR-205 A & B 206 A & B, 207 A & B	75014-1	Diodes, Germanium, 1% Tolerance	
I-101	55059-1	Lamp, Special, GE #53	
I-102		Lamp, Red, GE #53	
J-101	41153-1	Connector, Antenna, BNC, Male	
K-201	65126-16	Relay, Gold Contacts	
L-101-S-101, L-102-S-102, L-103-S-103	61298-1	Step Inductor, 20-position Switch	
L-104-S-104	61299-1	Step Inductor, 20-position Switch	
L-105-S-105	61300-1	Step Inductor, 20-position Switch	
L-106, 107, 108, 109, 110, 116, 119, 139, 140, 141	11138-9	Choke, Insulated,	2.2 uhy.
L-111	11412-120	Coil Assembly, Antenna	
L-112	11412-119	Coil Assembly, RF Plate	
L-113	11412-118	Coil Assembly, First Converter Grid	
L-114	11412-117	Coil Assembly, HFO Plate	
L-115	11412-121	Coil Assembly, LFO Plate	
L-117, 118	11285-102	Filter Inductor,	.59 hy
L-120	11138-2	Choke, Insulated,	.15 uhy
L-121, 122, 142, 143, 144	11138-7	Choke, Insulated,	1.0 uhy

L-123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138	11138-5	Choke, Insulated,	.47 uhy
L-201	11360-11	Choke,	150 uhy
M-201 A & B	76040-1	Meter, Dual-purpose, Miniature	
P-101	41198-1	Connector, 11-Pin Female, (41182-2, Clamp and Cap)	
Q-101	75506-3 or 4	Transistor, Power, Driver, Per Color Dot	
Q-102, 103 (12V)	75510-2	Transistor, Power, Matched Pair Per Color Dot	
Q-102, 103 (24V)	75511-2	Transistor, Power, Matched Pair Per Color Dot	
R-101, 124, 230, 228	31110-104	Resistor, Carbon, 10%, ½ watt,	100K ohm
R-102, 106, 116, 132, 210	31110-103	Resistor, Carbon, 10%, ½ watt,	10K ohm
R-103, 114	31141-222	Resistor, Carbon, 10%, ½ watt,	2.2 ohm
R-104, 108, 115, 249, 111, 113, 130	31141-101	Resistor, Carbon, 10%, ½ watt,	100 ohm
R-105, 109	31110-225	Resistor, Carbon, 10%, ½ watt,	2.2 megohm
R-110, 112, 107	31141-472	Resistor, Carbon, 10%, ½ watt,	4.7K ohm
R-111, 113	31141-121	Resistor, Carbon, 10%, ½ watt,	120 ohm
R-117, 118, 244, 237	31110-473	Resistor, Carbon, 10%, ½ watt,	47K ohm
R-119, 125, 126, 208, 233, 236, 212	31110-105	Resistor, Carbon, 10%, ½ watt,	1 megohm
R-120, 142	31141-122	Resistor, Carbon, 10%, ½ watt,	1.2K ohms
R-121	31141-682	Resistor, Carbon, 10%, ½ watt,	6.8K ohm
R-122	31110-393	Resistor, Carbon, 10%, ½ watt,	39 K ohm
R-123	31141-390	Resistor, Carbon, 10%, ½ watt,	39 ohm
R-127	31110-474	Resistor, Carbon, 10%, ½ watt,	470K ohm
R-128	32030-2	Potentiometer, Volume Control, Switch,	1 megohm
R-129	31110-475	Resistor, Carbon, 10%, ½ watt,	4.7 megohm
R-131	31141-821	Resistor, Carbon, 10%, ½ watt,	820 ohm
R-133, 134	31110-224	Resistor, Carbon, 10%, ½ watt,	220K ohm
R-136	31141-681	Resistor, Carbon, 10%, ½ watt,	680 ohm
R-136	31177-122	Resistor, Metallic Oxide, 1%, ½ watt,	1200 ohm
R-138	31141-820	Resistor, Carbon, 10%, ½ watt,	82 ohm
R-140, 141, 250, 251, 139, 144	31141-272	Resistor, Carbon, 10%, ½ watt,	2700 ohm
R-143	31179-1	Resistor, Temperature Compensating, 10%,	0.47 ohm
R-145	31134-116	Resistor, Wire-wound, 15 watt,	15 ohm
R-146	31136-680	Resistor, Carbon, 10%, 2 watt,	330 ohm
R-149	31161-8	Resistor, Wire-wound, 5%, 3 watt,	200 ohms
	31110-SEL	Resistor, Carbon, 10%, ½ watt,	Selected
R-150	31110-156	Resistor, Carbon, 10%, ½ watt,	15 megohm
R-151	31141-220	Resistor, Carbon, 10%, ½ watt,	22 ohm
R-152	31136-472	Resistor, Carbon, 10%, 2 watt,	4700 ohm
R-201	31110-564	Resistor, Carbon, 10%, ½ watt,	560K ohms
R-202	31177-154	Resistor, Meallic Oxide, 1%, ½ watt,	150K ohms
R-203	31177-264	Resistor, Metallic Oxide, ½ watt,	260K ohm
R-204	32031-1	Potentiometer, Trimit,	25K ohm
R-205	31141-152	Resistor, Carbon, 10%, ½ watt,	1.5K ohm
R-209, 234	31141-332	Resistor, Carbon, 10%, ½ watt,	3.3K ohm
R-211, 235	31110-334	Resistor, Carbon, 10%, ½ watt,	330K ohm
R-215	31141-223	Resistor, Carbon, ½ watt,	22K ohm
R-217	31141-470	Resistor, Carbon, 10%, ½ watt,	47 ohm
R-218, 221	31110-822	Resistor, Carbon, 10%, ½ watt,	8.2K ohm
R-219, 220	31110-273	Resistor, Carbon, 10%, ½ watt,	
R-222, 223, 135	31177-103	Resistor, Metallic Oxide, 1%, ½ watt,	10K ohm
R-224	32029-1	Potentiometer Course Selector,	27K ohm
R-225, 226	31177-123	Resistor, Metallic Oxide, 1%, ½ watt,	12K ohm
R-227, 229, 214	31110-106	Resistor, Carbon, 10%, ½ watt,	10 megohm
R-232	31141-271	Resistor, Carbon, 10%, ½ watt,	270 ohms
R-232	31110-682	Resistor, Carbon, 10%, ½ watt,	6.8K ohm
R-238	31149-271	Resistor, Carbon, 5%, ½ watt,	270 ohm
R-239 A & B	31176-3	Resistor, Wire-wound, 10%, 2% match,	820 ohm
R-240, 213, 242	31110-SEL	Resistor, Carbon, 10%, ½ watt,	SELECTED
R-241 A & B	31176-4	Resistor, Wire-wound, 10%, 2% match,	120 ohm
R-245	32031-2	Potentiometer, Trimit,	500 ohm
R-246	31110-331	Resistor, Carbon, 10%, ½ watt,	330 ohm
R-247	31110-182	Resistor, Carbon, 10%, ½ watt,	1.8K ohm
R-248	31162-1	Resistor, Wire-wound, 5 watt,	75 ohm
R-252	31162-7	Resistor, Wire-wound, 5 watt,	22 ohm
R-253	31161-1	Resistor, Wire-wound, 3 watt,	100 ohm

S-101		See L-101		
S-102		See L-102		
S-103		See L-103		
S-104		See L-104		
S-105		See L-105		
S-106	61302-1	Switch Section, Crystal Selector		
S-107	61301-1	Switch Section, Crystal Selector		
S-108	61306-101	Switch Section, Crystal Selector, KC		
S-109	61303-1	Switch Section, Glide Slope, Mc		
S-110	61304-1	Switch Section, Glide Slope, KC		
T-101, 102	11286-102	IF Transformer, 24.9 Mc.		
T-103, 104, 105	11287-102	IF Transformer, 7.0 Mc., Interstage		
T-106	11288-102	IF Transformer, 7.0 Mc., Output		
T-107	11272-102	Transformer, Transistor Driver		
T-108	11281-102	Transformer, Transistor Power Output		
T-201	11438-1	Transformer, Discriminator		
T-202, 203	11292-101	Transformer, Omni, 30 Cycle Output		
T-204	11440-2	Transformer, Localizer		
T-205	11440-1	Transformer, Localizer		
V-101, 102, 104	12DZ6			
V-103, 202	6922			
V-105, 107, 108	12EZ6			
V-106, 109	12EK6			
V-110	12J8			
V-111	6AL5			
V-201, 203, 204	12DY8			
XT-101 through XT-119	72012-103	Crystal, Quartz, Wire-in, MC Kit,	82.55 -	100.55 Mc.
XT-101	72007-75	Crystal, Quartz, Wire-in,	82.55 Mc.	108 Mc.
XT-102	72007-76	Crystal, Quartz, Wire-in,	83.55 Mc.	109 Mc.
XT-103	72007-77	Crystal, Quartz, Wire-in,	84.55 Mc.	110 Mc
XT-104	72007-78	Crystal, Quartz, Wire-in,	85.55 Mc.	111 Mc.
XT-105	72007-79	Crystal, Quartz, Wire-in,	86.55 Mc.	112 Mc.
XT-106	72007-80	Crystal, Quartz, Wire-in,	87.55 Mc.	113 Mc.
XT-107	72007-81	Crystal, Quartz, Wire-in,	88.55 Mc.	114 Mc.
XT-108	72007-82	Crystal, Quartz, Wire-in,	89.55 Mc.	115 Mc.
XT-109	72007-83	Crystal, Quartz, Wire-in,	90.55 Mc.	116 Mc.
XT-110	72007-84	Crystal, Quartz, Wire-in,	91.55 Mc.	117 Mc.
XT-111	72007-85	Crystal, Quartz, Wire-in,	92.55 Mc.	118 Mc.
XT-112	72007-86	Crystal, Quartz, Wire-in,	93.55 Mc.	119 Mc.
XT-113	72007-87	Crystal, Quartz, Wire-in,	94.55 Mc.	120 Mc.
XT-114	72007-88	Crystal, Quartz, Wire-in,	95.55 Mc.	121 Mc.
XT-115	72007-89	Crystal, Quartz, Wire-in,	96.55 Mc.	122 Mc.
XT-116	72007-90	Crystal, Quartz, Wire-in,	97.55 Mc.	123 Mc.
XT-117	72007-91	Crystal, Quartz, Wire-in,	98.55 Mc.	124 Mc.
XT-118	72007-92	Crystal, Quartz, Wire-in,	99.55 Mc.	125 Mc.
XT-119	72007-93	Crystal, Quartz, Wire-in,	100.55 Mc	126 Mc.
XT-120 through XT-129	72012-104	Crystal, Quartz, Plug-in, KC Kit,	32.45 -	33.35 Mc.
XT-120	72006-170	Crystal, Quartz, Plug-in,	32.45 Mc.	.00 Mc.
XT-121	72006-171	Crystal, Quartz, Plug-in,	32.55 Mc.	.10 Mc.
XT-122	72006-172	Crystal, Quartz, Plug-in,	32.65 Mc.	.20 Mc.
XT-123	72006-173	Crystal, Quartz, Plug-in,	32.75 Mc.	.30 Mc.
XT-124	72006-174	Crystal, Quartz, Plug-in,	32.85 Mc.	.40 Mc.
XT-125	72006-175	Crystal, Quartz, Plug-in,	32.95 Mc.	.50 Mc.
XT-126	72006-176	Crystal, Quartz, Plug-in,	33.05 Mc.	.60 Mc.
XT-127	72006-177	Crystal, Quartz, Plug-in,	33.15 Mc.	.70 Mc.
XT-128	72006-178	Crystal, Quartz, Plug-in,	33.25 Mc.	.80 Mc.
XT-129	72006-179	Crystal, Quartz, Plug-in,	33.35 Mc.	.90 Mc.

88101-3	Knob, Volume Control	55041-1	Mask, Light, Rubber
88101-1	Knob, KC Control	04116-1	Nameplate
88115-101	Dial Knob, MC	88118-101	Course Selector Dial
88111-101	Dial, Receiver, KC	82857-202	Trim Panel Screws
55026-3	Trim Panel (only)	41236-2	Banana Plug
55027-2	Mask, Trim Panel	55023-102	Case Assembly
55024-1	Diffuser, Light	55049-1	Pigtail Assembly, with Plug



Note: Use 30 cycle Reference Phase jack for Test Point 59; V-201, pin 6; V-202, pins 7, 8; V-203, pins 7, 8, 9.
Use 30 cycle Variable Phase jack for: V-202, pins 2, 3; V-204, pins 6, 8, 9.

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NARCO AVIONICS

MARK 8 NAV/COM

14 VOLT

MAINTENANCE MANUAL

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

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5. REPLACEMENT PARTS LIST

6. SCHEMATICS

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1.1 GENERAL

The NARCO AVIONICS MARK 8 is a combination crystal controlled 190 channel (100 NAV/90 COM) tranceiver together with LEFT-RIGHT and TO-FROM Indicators and a OMNI BEARING SELECTOR. The unit is designed to be instrument panel mounted and to operate at 14 vdc. The Mark 8 may be connected with a speaker/headphone and uses a standard aircraft microphone. Separate transmit and receive antennas are required.

The manual channel selector on the Front Panel enables selection of any one of the 190 crystal controlled channels: 100 Navigation (OMNI/LOC), 90 simplex COM. When the Mark 8 is channeled to receive VOR information (even tenths 108.0 thru 111.8 MHz and all channels 112.0 thru 117.9 MHz) the Indicator is activated to show LEFT-RIGHT and TO-FROM deviation from the radial chosen on the OMNI Bearing Selector dial. It also provides voice and identification (IDENT) signals to the headphone/speaker circuits. When the Mark 8 is channeled to receive Localizer information (odd tenths 108.1 thru 111.9 MHz) the TO-FROM indicator shows TO anytime a suitable localizer signal is received. The LEFT-RIGHT meter indicates the instantaneous location of the aircraft with reference to the center of the runway.

The OMNI Bearing Selector (OBS) dial is rotated by turning the knob labled OBS.

The Mark 8 contains a special transmitter circuit, which provides transmitter operation automatically on 122.1 MHz whenever the channel selectors are set to any one of the 100 Navigation channels. This permits communication with Flight Service Stations (FSS) by listening on the associated VOR facility. Navigation signals are interrupted only briefly during transmissions.

The audio system contains an IDENT filter to eliminate the code identification from a NAV signal so voice communications can be clearly understood. The volume control knob rotates to turn the Mark 8 ON and OFF and to adjust the volume. Pulling the volume control knob disables the IDENT filter so coded IDENT can be heard.

In the Communications range of 118.0 thru 126.9 MHz the receiver and transmitter are always tuned to the same frequency, to provide simplex operation.

2.1 INTRODUCTION

This section contains detailed instructions for the installation and basic operation of the Narco Mark 8 NAV/COM. A complete installation consists of the Panel Unit, two antennas (receive and transmit), loudspeaker and/or headphones, a microphone, and necessary interconnecting cables.

2.2 SPECIFICATIONS

2.2.1 Mechanical

Size: Panel Unit (See Figure 2-6)
Weight: Panel Unit including Case, Cabling, and connector: 7.0 pounds

2.2.2 Electrical

14 volt operation only
Current: 5.2 amps receive
6.2 amps transmit

2.2.2.1 RECEIVER

Frequency Coverage:
190 Channels, 0.1 MHz spacing 108.0 thru 126.9 MHz

Sensitivity:
NAV band 1.5 μv for 6 db signal plus noise to noise ratio
COM band 2.5 μv for 6 db signal plus noise to noise ratio

Image Rejection:
55 db minimum (NAV) 40 db minimum (COM)

Selectivity:
6 db (nose). ±19 kHz minimum bandwidth
60 db (skirt), ±110 kHz maximum bandwidth

AVC Flatness:
4 db from 10 to 10,000 microvolts

Tone Filter:
Provides 15 db minimum IDENT signal rejection

Audio Output:
Speaker — 4 watts minimum into 4.0 ohms
Headphones — 100 milliwatts into 600 ohms

Omni Accuracy:
±4° maximum error

2.2.2.2 TRANSMITTER

Power Output:
2 watts

Modulation:
70% minimum, before clipping 85%

Frequency Stability:
Maximum ±.005% over temperature range of –30°C to +55°C and line voltage variation of 11 volts to 16 volts

Microphone Input:
Low Impedance (carbon)

Duty Cycle:
20% maximum (1 minute on, 4 minutes off)

2.3 UNITS AND ACCESSORIES SUPPLIED

A. Mark 8.

B. Cable Assembly, Power, Audio, and Dimmer, Part No. 90632-54

C. Antenna Connector, Transmitter, Part No. 41130-1

D. Antenna Connector, Receiver, Part No. 41237-1, plug; with 41237-2 ferrule

2.4 ACCESSORIES REQUIRED, but not SUPPLIED

A. Receiving Antenna: Narco VRP-37 tail mounting type with 30 foot RF cable and "Balun", Part No. 05507-0000. See Section 2.9.1.

B. Transmitting Antenna: Narco Type VTP-17 bent rod type with 100 inches RF cable, Part No. 05504-000, or VP-10 broad band type with gasket, hardware, and BNC connector, Part No. 05502-0000. See Section 2.9.2.

C. Loudspeaker/Headphones:

1. Loudspeaker—voice coil impedance, 4 ohms.
2. Headphones—low impedance type, 300 to 1000 ohms. Both headphones and speaker may be used simultaneously.

D. Microphone: carbon, noise cancelling type (low impedance)

The quality of transmission depends on the microphone. A noise-cancelling type is necessary to reduce background noises to an acceptable level. A noise-cancelling dynamic microphone with transistor amplifier having the same output level as carbon microphones usually produces the most intelligible voice transmission.

2.5 OPTIONAL ACCESSORIES

A. Cooling Kit, Narco EL-3076-501.

B. Frequency Change Kit, NAV Transmitter, Narco EL-3076-503 (Supplied with one of the following, as ordered: 122.4, 122.5, 122.6, or 122.7 MHz)

2.6 LICENSE REQUIREMENTS

The Federal Communications Commission requires that the operator of the transmitter in this equipment hold a Restricted Radio Telephone Operator Permit, or higher class license. A permit may be obtained by any U.S. citizen from the nearest field office of the FCC; no examination is required.

The transmitter itself, as installed in the aircraft, requires an Aircraft Radio Station License. This license

is obtained by filing FCC Form 404. The Mark 8 may be operated for up to 30 days without a station license, after filing the FCC Form 404 and while awaiting receipt of the station license, providing a copy of the FCC Form 404 is kept in the aircraft.

This equipment has been type accepted by the FCC and entered on their list of type accepted equipments as "Narco Mark 8" and it must be identified as "Narco Mark 8" on your FCC Aircraft Radio Station License Application.

CAUTION:

The VHF transmitter in this equipment is guaranteed to meet Federal Communications Commission approval only when NARCO crystals are used.
Use of other than NARCO crystals will void manufacturers warranty.

2.7 MECHANICAL INSTALLATION

The Narco Mark 8 Panel Unit is secured to its case by a latch. The latch is activated by turning the locking shaft (located under the snap-in button on the front panel) with an Allen wrench. The most desirable installation for the best appearance is to mount the case from the rear of the instrument panel. A cutout 6-5/32 x 3-1/32 inches high is required in the instrument panel to allow the Panel Unit to slip thru and be secured in place, leaving only the front trim portion visible. (See Figure 2-7., removable for a full-size cutout template.) If for any reason the case cannot be rear-mounted, the instrument panel cutout should measure 6-9/32 x 3-5/32 inches high to allow the case to slip thru.

This installation will leave a visible gap around the trim panel. A cover plate can be fabricated and secured to the instrument panel after installing the case to enhance the appearance of this type of installation. (See Figure 2-7, removable for a full-size cutout template.)

2.7.1 Case Mounting Supports

The Panel Unit is supported by its case which is provided with drilled "bosses" on the top, bottom, and sides to accommodate binding head screws. Mounting brackets to mate these bosses are not supplied due to the wide range in mounting requirements. Suitable mounting brackets may be fabricated from ordinary metal sheet or angle stock.

The 10-32 machine screw provided at the rear of the case performs a dual function: (1) an electrical ground connection, and (2) a mechanical rear support attachment point.

To support the rear of the case a metal bracket should be fabricated and attached to the 10-32 machine screw and a firm airframe member. The airframe-bracket joint must make good electrical connection, or a separate ground strap must be provided.

To provide sufficient support, the case should be mounted in *one* of the following methods. (See Figure 2-1.)

1. Screws and bracket at: A and B, plus G or H.
2. Screws and ground strap at: A, B, E, and F, plus I.
3. Screws and bracket at C and D, plus G or H.
4. Screws and ground strap at: C, D, E, and F, plus I.

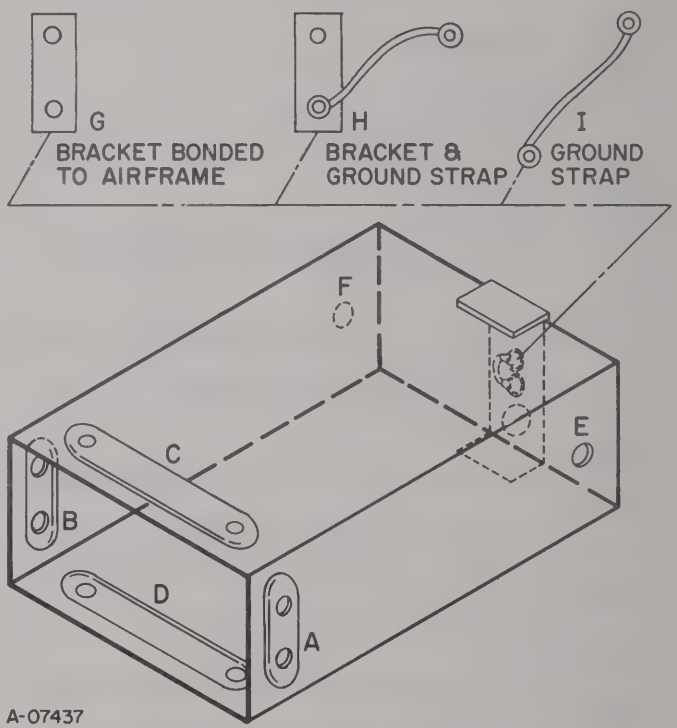


Figure 2-1. CASE MOUNTING

2.7.2 Panel Unit Ventilation

When the Mark 8 is to be mounted in a stack with other radio equipment, a flow of cooling air is essential. Cooling is desirable for single radio installations as well. If the airframe does not provide cooling air to the radio, a Narco Cooling Kit (EL-3076-501) should be installed. This Kit consists of a small air scoop to be mounted outside the cabin, a plenum, and a flexible hose. It connects to the air inlet at the rear of the Mark 8, near the lower center of the unit.

2.8 ELECTRICAL CONNECTIONS

All electrical connections are made at the rear of the Panel Unit. The case is provided with a ground support stud on the vertical strap at the rear of the case. The strap also has a grounding jack which mates with a plug on the chassis. A good electrical connection must be made between the ground support stud and the metal frame of the aircraft. The receiver (J-101) and transmitter (J-301) connectors are mounted directly on the rear of the Unit.

The remaining connections are made via an eleven pin connector (P-401) at the end of a short cable extending from the rear of the Unit. This connector mates with J-401 of the seven wire cable assembly supplied. (See Figure 2-2.)

2.8.1 Primary Power

A wire, RED No. 16, about 10" long extends directly from connector J-401. It is connected to the aircraft 14 volt dc supply via a circuit breaker or fuse rated at 15 amps.

2.8.2 Dimmer Circuit

A wire, WHITE No. 22, about 10" long extends directly from the connector J-401. It connects with the front panel lamps in the Unit and may be connected to a common instrument panel lamp dimmer circuit. If dimmer operation is not desired, the wire must be connected to terminal No. 2 in J-401. This provides +14 vdc to the panel lamps when the Mark 8 is turned ON.

2.8.3 Audio Circuits

The five wire cable is provided for the audio circuits. (See Figure 2-2). The BLUE, WHITE, BROWN, and BLACK wires are connected to the mike and phone jacks supplied by the installer.

The GREEN wire is the loudspeaker lead. It should be extended as necessary to reach the speaker.

2.8.4 Autopilot Output

The Mark 8 can provide OMNI/LOC information to an Autopilot Coupler. Couplers having an input impedance of 5000 ohms or greater may be connected directly across pins 9 and 10 of P-401. Signal level available is 40 millivolts across 10K ohm load impedance for a 10 degree course change on OMNI or 4 db modulation difference in LOC signal level. Neither AUTOPILOT input lead may be grounded.

PIN No	WIRE COLOR	CIRCUIT
1	RED No16 10" LONG	DC SUPPLY (+14V.DC)
2	——	SWITCHED +14V.DC
3	WHITE No 22 10" LONG	EXTERNAL PILOT LIGHT DIMMER
4	GREEN	TO LOUD-SPEAKER
5	BLUE	TO HEAD-PHONES
6	WHITE	TRANS. CONTROL (MIC. TIP)
7	BROWN	MIC. AUDIO (MIC. RING)
8	BLACK	AUDIO GND. FOR MIC, SPKR PHONES
9	——	+ RIGHT AUTOPILOT INFO.
10	——	+ LEFT AUTOPILOT INFO.
11	——	D.C. CHASSIS GROUND

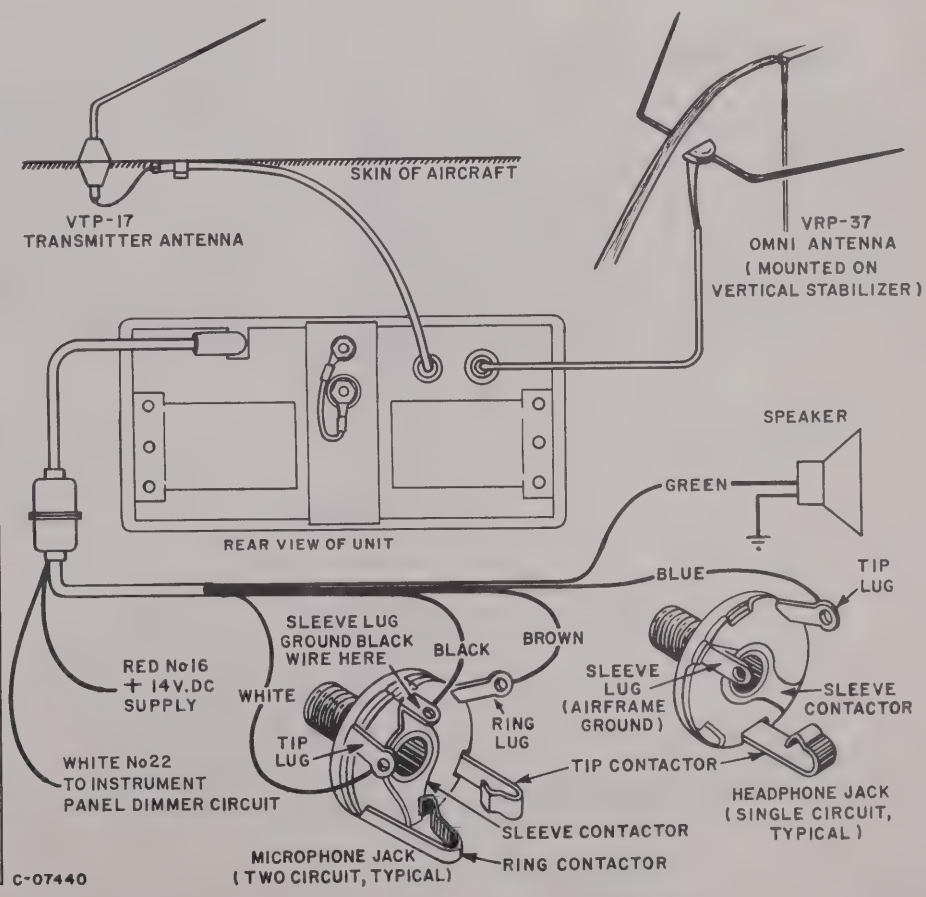


Figure 2-2. POWER, AUDIO, AND ANTENNA CABLE CONNECTIONS

2.9 ANTENNAS

2.9.1 Receiving Antennas

The full range and accuracy of the VHF omni range system can be realized only when the airplane is equipped with the proper type of antenna. For omni range reception, a horizontally polarized antenna is absolutely necessary. A vertical whip is definitely not satisfactory, although it may appear to be when tried. Vertically polarized components are not radiated by the ground stations, but are produced by reflections from objects on the ground. Therefore a vertical antenna may receive strong signals, but they are reflections, not coming directly from the ground station. They cause bearing errors and needle wander.

Tail mounting antenna, Narco Type VRP-37, is available for mounting on the upper part of the vertical stabilizer. The VRP-37 is available with an external balun which attaches to the antenna rods. The other end of the balun is factory connected to the coaxial RF cable which connects to the equipment. The balun is made of coaxial RF cable, cut to critical dimensions, which should not be altered. The sheath of the coaxial line to the receiver should be connected to the sheath of the balun cable and grounded directly to the metal surface of the airplane. The VRP-37 Cable Assembly has a grounding lug for making this connection.

2.9.2 Transmitting Antenna

The vertical rod type transmitting antenna, such as the Narco VTP-17, should be mounted on a metal surface measuring at least 18 inches square to serve as a ground plane. Such a mounting surface is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface is available a piece of thin aluminum may sometimes be affixed flush with the fabric. This thin aluminum sheet or foil may be made to conform to the various curved surfaces to which it is mounted, but all cuts and seams should be along lines radiating from the antenna base. A ½ inch dia. hole should be made in the center of this sheet for mounting the antenna. A doubler plate is usually required to resist the bending load imposed by the slip-stream. The Narco VTP-17 antenna should not be lengthened or shortened. It has been cut to the proper length for the most efficient radiation at the frequencies generated by the transmitter.

2.9.3 Antenna Cables

The type VTP-17 transmitting antenna is available with 100 inch lengths of 52 ohm coaxial transmission line, type RG-58A/U. The alternate type of receiving antenna, type VRP-37, is available with 30 feet of RG-58A/U, 52 ohm coaxial transmission line with an attached balun.

Extra long cables can be obtained on special order from the factory, complete with end fittings, or can be assembled in the field.

The VTP-17 transmitter antenna cable has a phono-type connector on the set end and lug and clamp fittings on the antenna end. Thus the cables are not directly interchangeable at either end.

2.9.4 Ignition Shielding

It is possible in some types of airplanes to get satisfactory reception without special precautions. However, it is always advisable and frequently necessary to provide properly fitted ignition shielding. It has been found that such shielding when not in first-class condition as to clean and tight joints, etc., can cause a lot of noise, particularly at VHF. It is, therefore, recommended that any ignition shielding in the airplane in which the equipment is being installed be thoroughly inspected, and overhauled if necessary, at the time of installation.

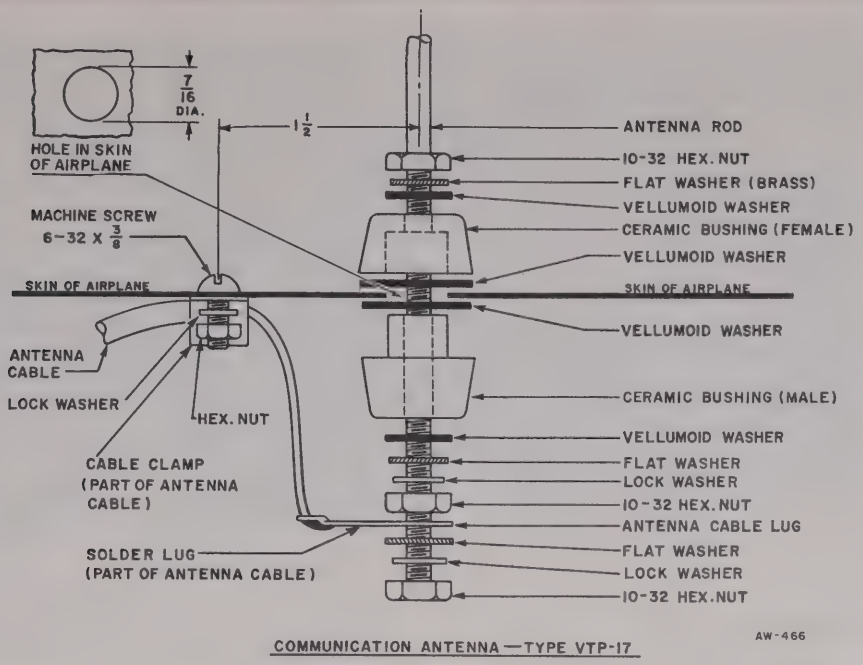


Figure 2-3. TRANSMITTER ANTENNA INSTALLATION DIAGRAM

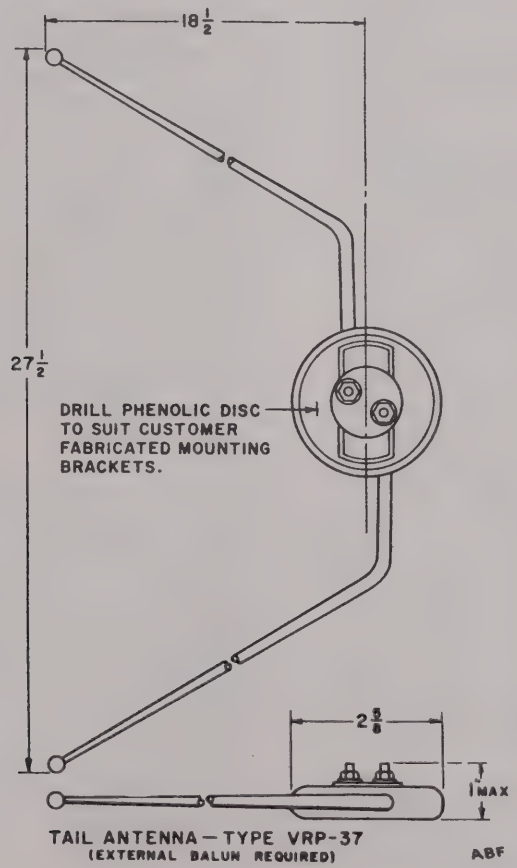


Figure 2-4. OMNI NAV/REC ANTENNA INSTALLATION DIAGRAM

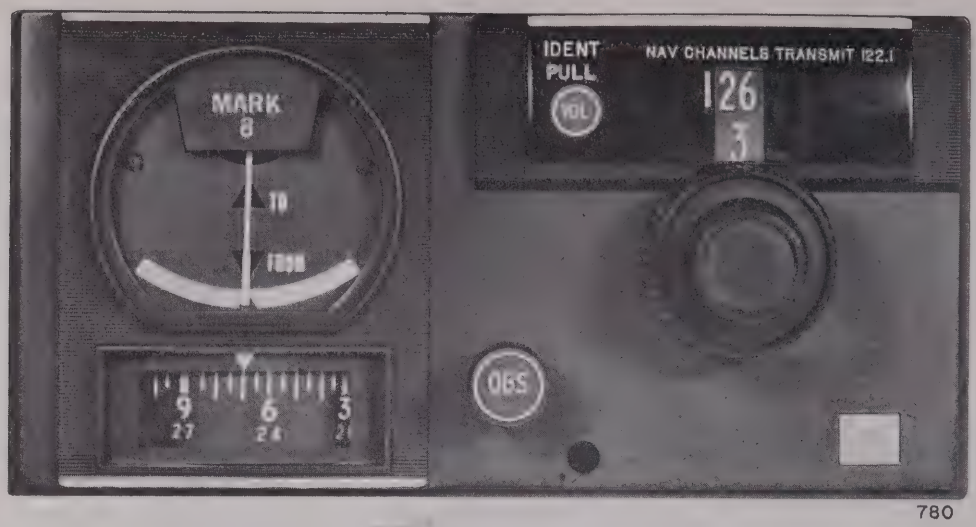


Figure 2-5. MARK 8 FRONT PANEL CONTROLS

2.10 PANEL CONTROLS

2.10.1 Volume (VOL)

The small knob labeled VOL operates the: ON-OFF switch; controls the volume; and activates the IDENT filter circuit.

This control is directly on the +14 vdc line. OFF is the maximum counterclockwise position. Volume is increased with clockwise rotation.

A 1020 Hz filter circuit is provided in the receiver to attenuate the tone ident signal present on Omni/LOC stations. The filter is shorted out and ident signals can be heard when the VOL control knob is pulled out. Pushing the knob inactivates the filter attenuating the coded ident. Voice signals are not effected.

2.10.2 Channel Selector

The Channel Selector consists of a large outer knob to select the whole megahertz and a smaller knob to select the tenths (fractional) megahertz. Both knobs operate the crystal selector switches and step inductors.

The Channel Selector provides positive detent switching for all NAV and COM channels. Operation of both knobs is continuous, in either direction, without stops. In the Navigation range of 108.0 thru 117.9 MHz the transmitter is always tuned to 122.1 MHz, the dual channel simplex air-to-ground Flight Service Station (FSS) frequency.

In the Communications range of 118.0 thru 126.9 MHz the receiver and transmitter are always tuned to the same frequency for single-channel simplex operation.

2.10.3 Indicator and Course Selector

The indicator meter, I-201, operates on all NAV channels, VOR, and ILS LOCALIZER (108.0 thru 117.9 MHz). When the Channel Selector is set to an ILS LOCALIZER channel (odd tenths: 108.1 thru 111.9 MHz) the indicator shows left or right deviation from the runway center line. When a VOR channel is selected (even tenths: 108.0 thru 111.8 MHz and all channels 112.0 thru 117.9 MHz) the indicator shows left or right deviation from the course chosen on the course selector dial.

The indicator provides TO-FROM and weak signal indications in the form of white triangles. If the TO or FROM triangle is not completely filled by the white flag, the signal is weak and the course indication may not be reliable. One triangle, TO or FROM, will appear completely white when the indicator needle is centered regardless of the aircraft heading. This indication is the magnetic bearing (TO or FROM) the selected VOR station.

The Omni Bearing Selector is rotated by turning the knob labeled OBS. To set the OBS to a desired Omni radial, rotate the OBS knob until the desired course bearing number is centered under the white arrow on the OBS lens. The large numbers are the course bearing in degrees, the small numbers directly below are the reciprocal course bearing.

2.11 POST INSTALLATION CHECK-OUT

After the installation has been completed, it should be operated on the ground thru the antennas with all normal power turned on and the engine(s) running. The receivers should be checked for proper operation by channeling to available signals. A ground check of the transmitter should be made to determine output and audio quality. This may be done by contacting the control tower of any other communication facility.

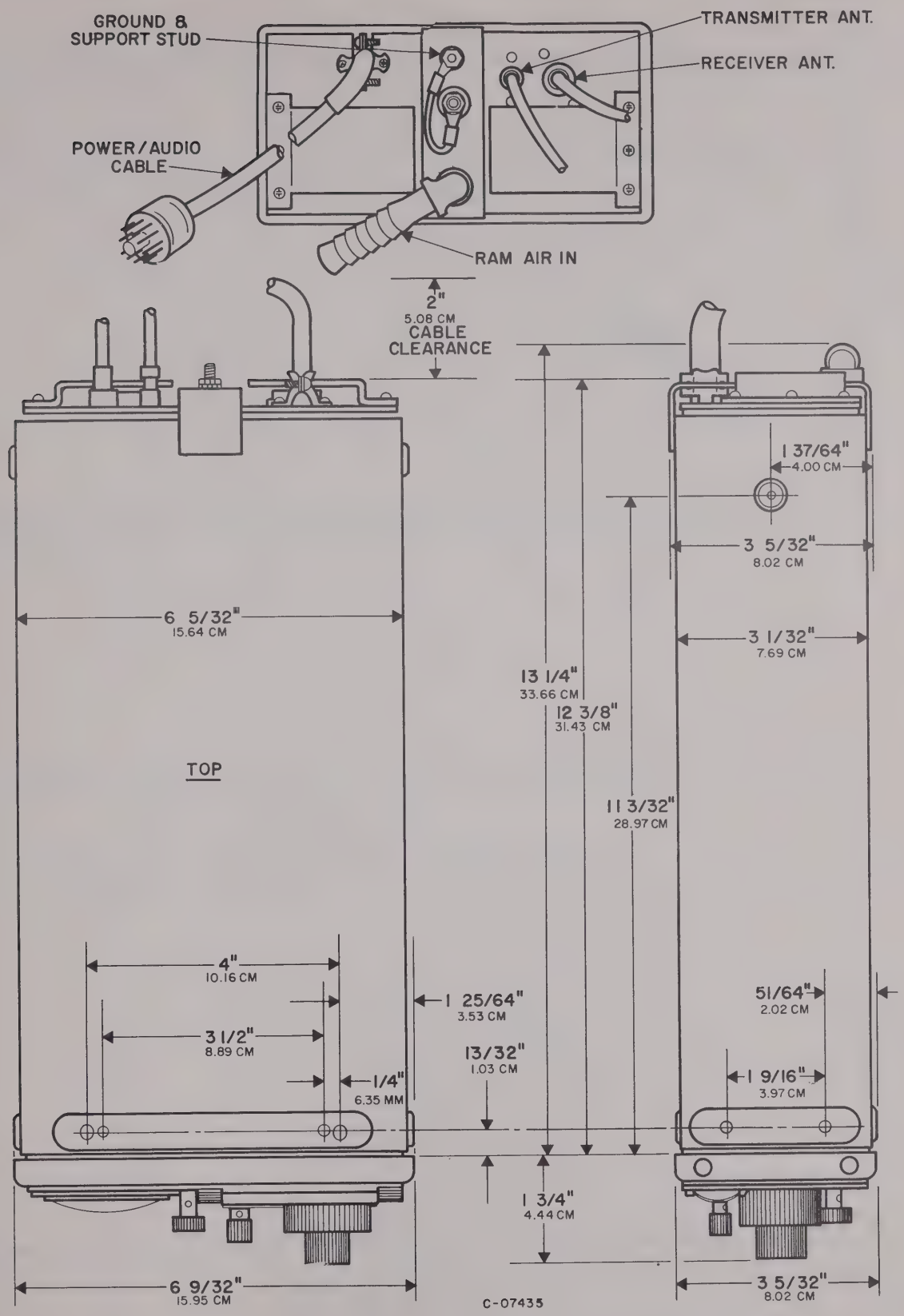
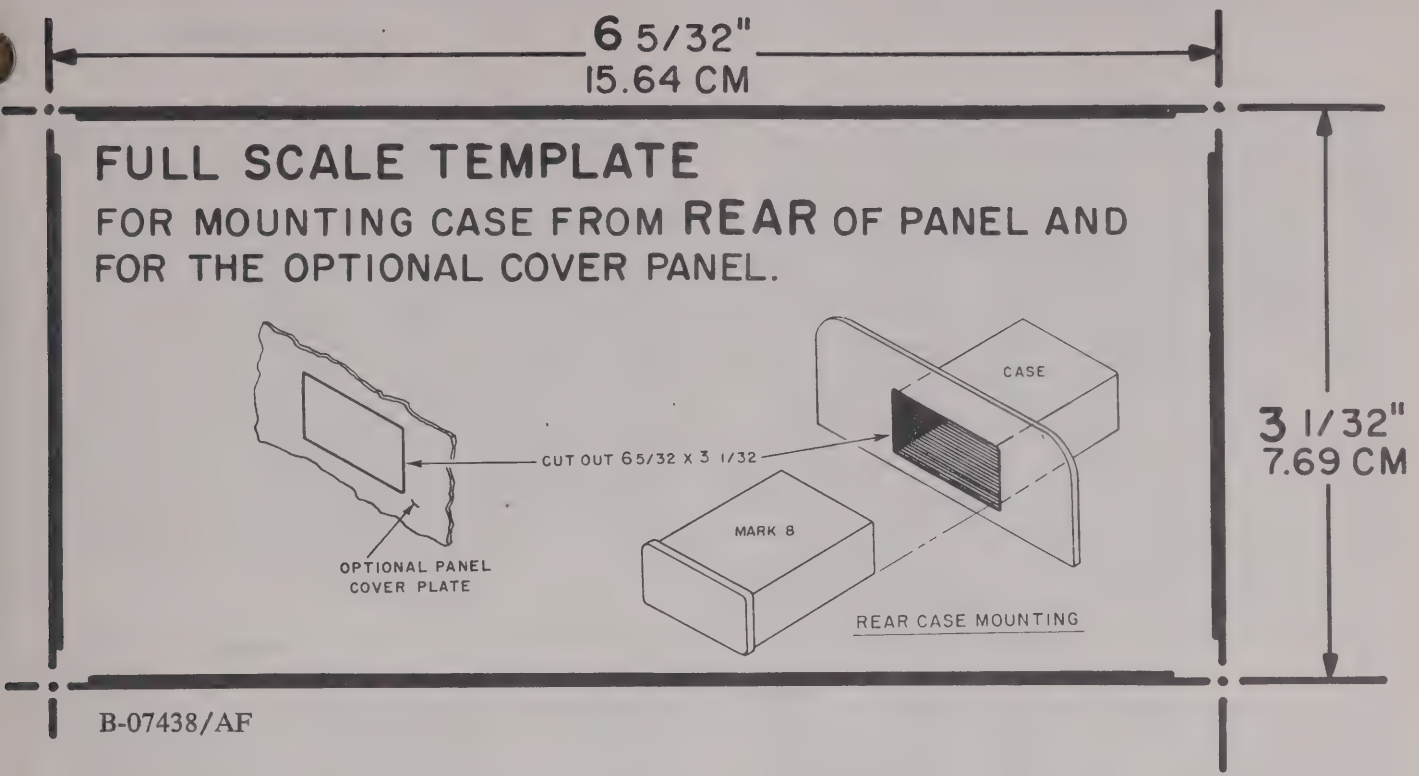


Figure 2-6. MARK 8 INSTALLATION DIAGRAM



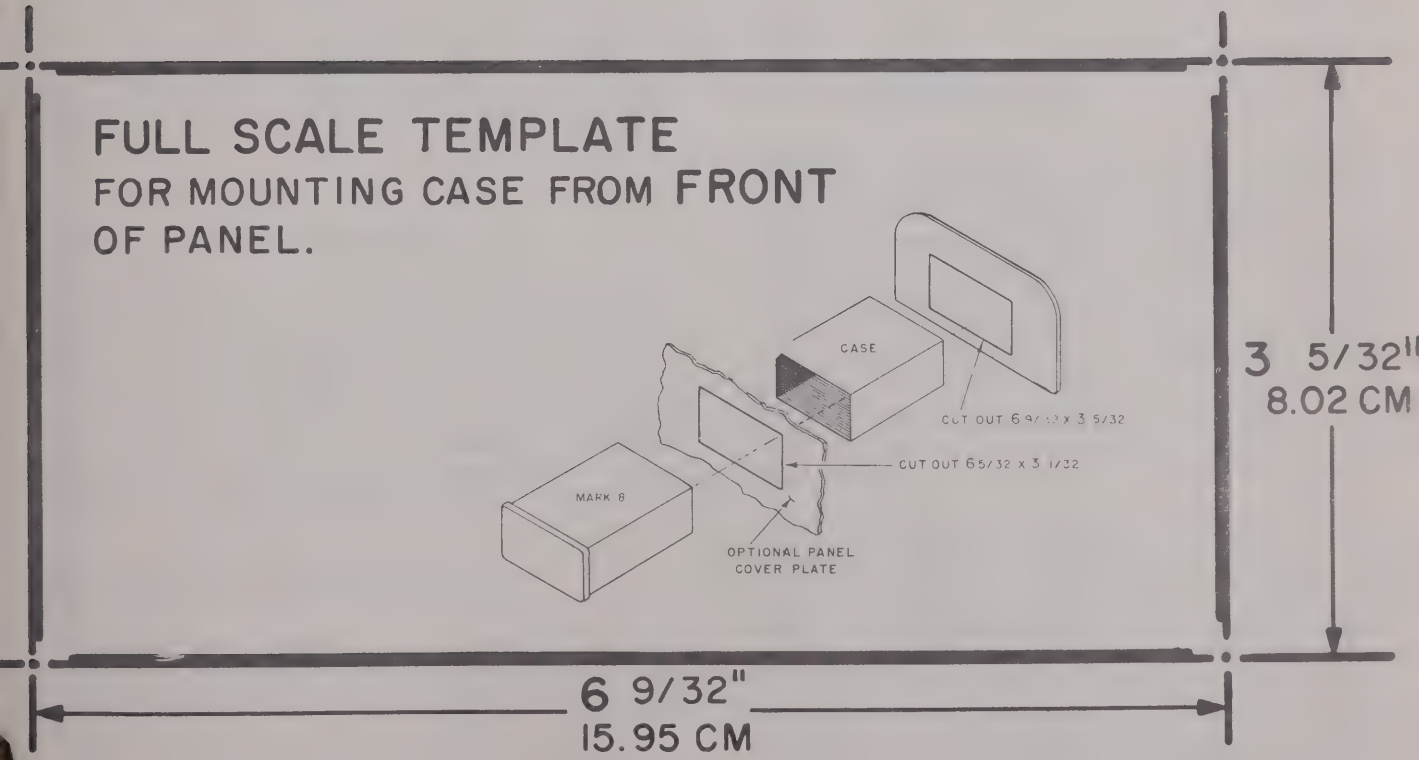


Figure 2-7. MARK 8 FRONT PANEL TEMPLATE

3.1 INTRODUCTION

The NARCO Mark 8 NAV/COM channel selector provides positive detent step tuning for all 190 channels, 108.0 thru 126.9 megahertz (MHz). In the communications range of 118.0 thru 126.9 MHz the transmitter and receiver are always tuned to the same frequency, for simplex operation. On all navigation channels 108.0 thru 117.9 MHz special circuit switching is provided so that the transmitter is always on the enroute frequency of 122.1 MHz. A separate crystal is provided for this purpose. Also, when a navigation frequency is selected, the INDICATOR, M-201, is automatically switched to the VOR or ILS LOCALIZER circuits, depending on the channel selected. Twenty channels, odd tenths MHz 108.1 thru 111.9 are ILS LOCALIZER channels. The remaining 80 channels are assigned to VOR service.

3.1.1 Receiver

The receiver is a double conversion superhetrodyne type having a first IF in the vicinity of 17.1 MHz for the navigation frequency range and a first IF in the vicinity of 9.1 MHz for the communications range. The second IF is fixed at 4.0 MHz on all channels.

3.1.2 Transmitter

The transmitter output frequency is obtained by combining two oscillator frequencies in a balanced mixer circuit and amplifying the desired resultant frequency.

3.1.3 Omni and Localizer

The OMNI and LOCALIZER converter circuits operate from the receiver section detector, CR-103, output. Visual information is displayed on the INDICATOR. Aural identification may be controlled by the IDENT-ON-OFF switch. Details of the various circuits are given in succeeding paragraphs in this section, in the Block Diagram, Figure 3-1 and in the Schematic Diagram, Figure 6-2.

3.2 CIRCUIT ARRANGEMENT

The transmitter, receiver, and navigation sections employ fairly conventional circuits except for the crystal frequency control arrangement. The high frequency oscillator (HFO), doubler, mixer, and amplifier circuits for the receiver and transmitter are separate, however, the low frequency oscillator (LFO) is common to both the transmitter and receiver.

The crystal utilization and circuit design is unique in that a single set of 15 crystals (XT-301 thru XT-315) provide a total of 190 receiver and 90 transmitter channels. This is accomplished by operating crystals of the overtone type on both their fundamental and fifth overtone modes. The fundamental frequencies in the range of approximately 13.5 to 12.6 MHz are used by the common LFO to provide the low mixer injection frequencies for both the transmitter and the receiver. The fifth overtone frequencies in the range of approximately 62.7 MHz to 69.7 MHz are used by separate HFO circuits to provide injection to the receiver mixer and transmitter HFO DBLR.

On some channels a given crystal may be functioning on both its fundamental frequency and the fifth overtone at the same time. The overtone frequency is not an exact multiple of the fundamental frequency. For details of the crystal frequency arrangement, see Tables 3.1 and 3.2.

The 122.1 MHz transmitter channel used with all of the navigation channels is a conventional oscillator, doubler, amplifier arrangement. It uses a separate crystal XT-316.

3.3 NAVIGATION/COMMUNICATION RECEIVER

A crystal controlled, double conversion superheterodyne circuit is employed in the receiver of the Mark 8. The desired signal enters the receiver at the antenna connection, J-101. Under certain conditions, there may be spurious responses from nearby FM broadcasting stations appearing in the navigation channels. To avoid such spurious responses, a series tuned trap, L-107 and C-147, shunted across the receiver antenna connector, J-101, tuned to 98 MHz has been incorporated. Two separate oscillators are used in the receiver, both using a common set of crystals.

The high frequency oscillator (REC HFO), V-2B, is a crystal stabilized modified Colpitts oscillator using the triode section of a 6KE8 tube. The frequency range, using the fifth overtone of the crystals is approximately 62.7 MHz to 67.7 MHz in 0.5 MHz steps. The HFO energy is injected through C-109 into the control grid of the first mixer V-2A, where it doubled and mixed with the incoming RF signal from the RF amplifier, V-1A. The difference in frequency between the incoming RF signal and two (2) times the HFO is the high frequency IF (first IF).

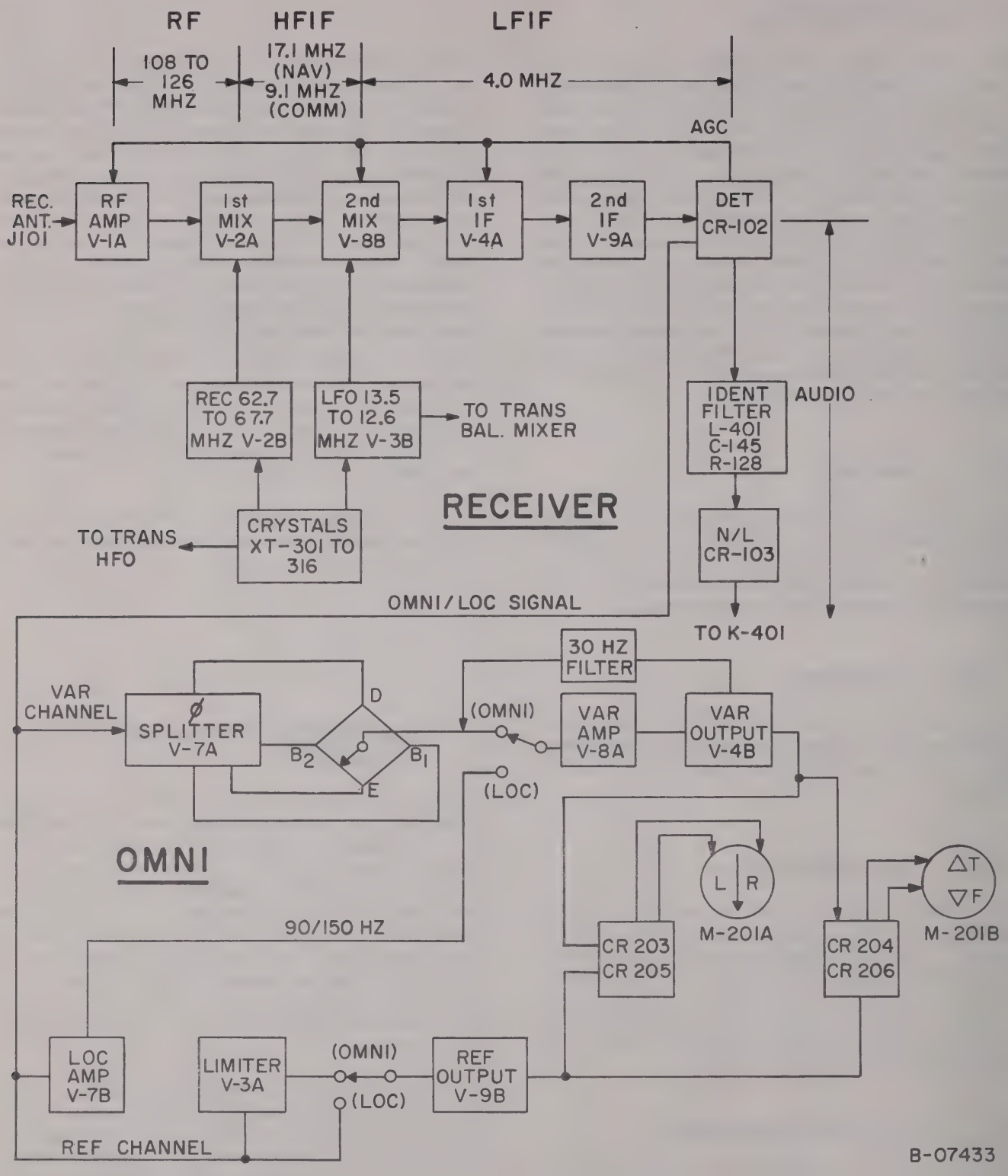


Figure 3-1 MARK 8 RECEIVER/OMNI BLOCK DIAGRAM (See Paragraph 3.1.3)

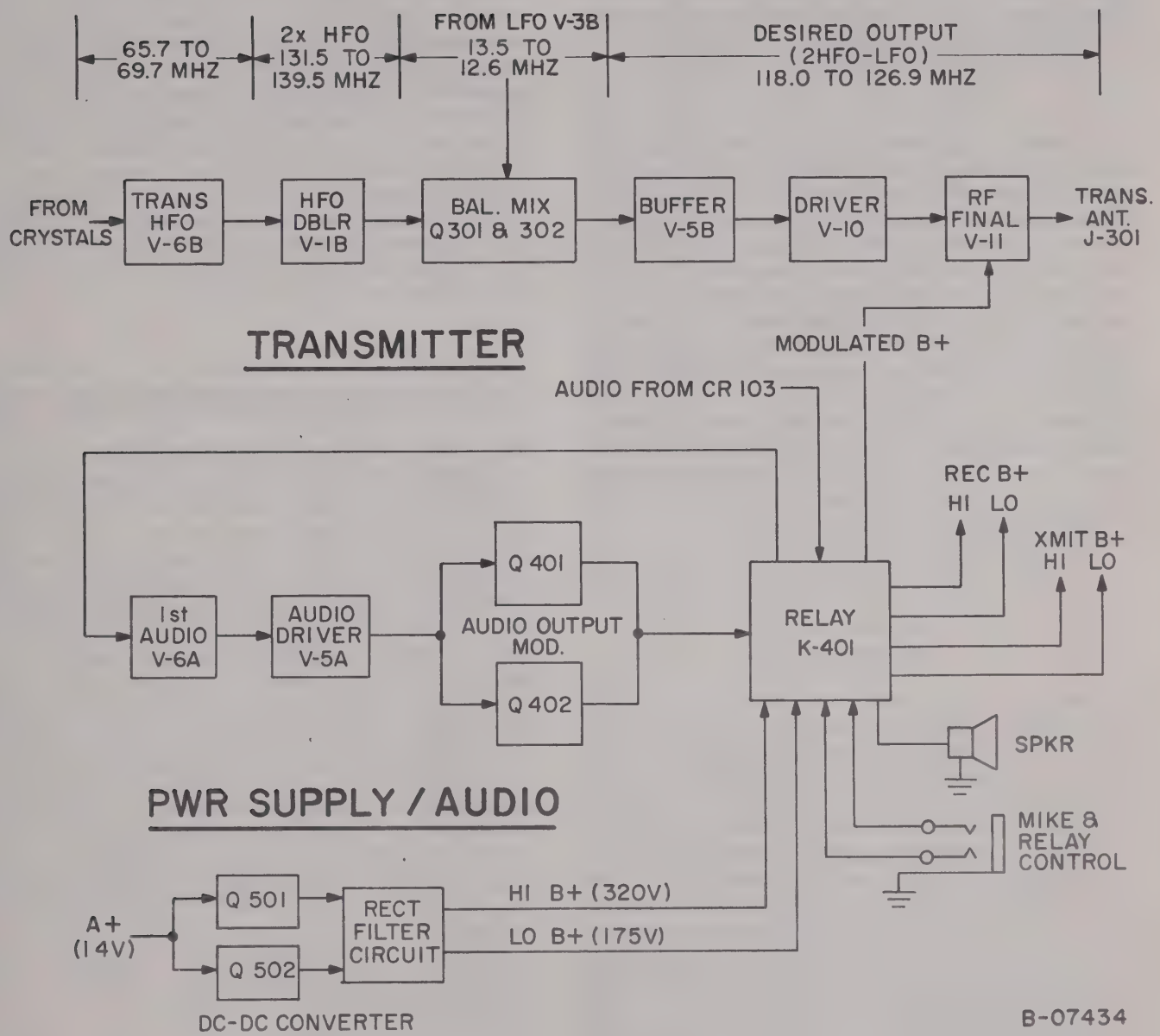


Figure 3-2 MARK 8 TRANSMITTER /POWER SUPPLY /AUDIO BLOCK DIAGRAM (See Paragraph 3.1.3, 4.5.2)

On navigation channels, the HF IF is from approximately 17.5 to 16.6 MHz. The transformer T-101 is switched into the plate circuit of V-2A and tracks over this frequency range. On communication channels, the HF IF is from approximately 9.5 to 8.6 MHz. The transformer T-102 is switched into the plate circuit of V-2A and tracks over this range. Switch wafers controlled by the channel selector choose the proper HF IF circuit for the frequency range being tuned. The output of the HF IF is applied to the control grid of the second mixer,V-8B.

The low frequency oscillator (LFO) (V-3B), is a crystal stablized, modified Colpitts oscillator operating on the fundamental frequency of the crystals, approximately 13.5 to 12.6 MHz in tenths MHz steps. The output of the oscillator is inductively coupled into the cathode of the second mixer V-8B through L-329. The low frequency (4.0 MHz fixed) IF (second IF) is produced by selecting the difference frequency between the high frequency IF output and the LFO injection frequency. This selection is done by T-103, which is the first of three 4.0 MHz IF transformers. The signal from T-103 is applied to the control grid of V-4A. It is amplified by V-4A, applied through T-104 to V-9A where it is again amplified. It is then applied through T-105 to CR-102, which is a silicon diode detector.

NOTE: The LFO circuit is used by both transmitter and receiver.

The output of the detector is fed into an IDENT tone filter network, consisting of C-145, L-401, and R-128. This filter is switched in and out of the circuit by S-102, which is controlled by pushing or pulling the knob on the volume control ON-OFF switch assembly on the front panel. This filter is used on the navigation frequencies to eliminate the 1020 cycle IDENT tone used for identification of OMNI stations. When the knob on the front panel of the unit (S-102) is pushed in, the IDENT tone on the OMNI station being received is greatly reduced and any voice transmission on the channel may be clearly heard. Pulling the knob out allows the tone identification to be heard, to identify the OMNI station being received. The output of the IDENT filter is passed through a peak limiting noise limiter, CR-103, to the input of the audio volume control, R-129. The output of the volume control is applied through C-401 to the control grid of V-6A, the first audio amplifier.

AGC voltage is developed by detector current through R-124 in the CR-102 detector output circuit. AGC voltage is applied to the RF and IF stages with the exception of the first mixer, V-2A, and the last IF amplifier, V-9A. On navigation channels (108.0 - 117.9 MHz) S-301-A adds C-121 (0.22 uf) to increase the time constant.

The plate circuit of the first audio amplifier (V-6A) is resistance coupled to the grid of the audio driver V-5A. The output of the audio driver stage is transformed coupled by T-401 to a push-pull transistorized audio amplifier/modulator circuit. The collectors of the push-pull transistors Q-401 and Q-402 are connected to a center-tapped output/modulator transformer T-402. This transformer contains two windings, a low impedance winding tapped to match a four (4) ohm speaker voice coil and one or two pairs of 600 ohm headphones and a high impedance winding used to plate modulate the transmitter RF amplifier V-11. The headphone circuit is wired such that a sidetone signal is available while transmitting.

3.4 COMMUNICATIONS TRANSMITTER

There are 90 crystal controlled transmitter channels provided by the Mark 8. The transmitter is of the heterodyne type. Two separate oscillators are used, both using a common set of crystals. The low frequency oscillator (LFO) uses the fundamental frequency of the crystals, approximately 13.5 to 12.6 MHz. The high frequency oscillator (HFO) uses the fifth overtone of the crystals, approximately 65.7 to 69.7 MHz. The HFO output is doubled into a balanced transistor mixer, Q-301 and Q-302. The desired transmitter frequency equals two (2) times HFO minus LFO, except when a navigation channel is selected. Additional contacts on the transmitter crystal switch and step inductors select a special crystal (XT-316) and necessary coils (L-331, L-332, L-333, L-334, L-335) to operate the transmitter on 122.1. The LFO is not used in transmit over the range of 108.0 to 117.9 (refer to Schematic Diagram, Figure 6-3, Switch S-301). The transmitter will operate only on 122.1 during receiver operation in the 108.0 to 117.9 MHz range. Switching to the communications channels will again place the transmitter in its simplex mode of operation.

The transmitter high frequency oscillator (TRANS. HFO) is a crystal stabilized modified Colpitts circuit using the triode section of V-6B, a 6GH8A tube. The frequency range using the fifth overtone of the crystals is approximately 65.7 MHz in 0.5 MHz steps. The output frequency of the HFO is coupled by C-313 to the grid of the frequency doubler V-1B. The doubled HFO frequency is fed to the balanced mixer (BAL. MIX), Q-301 and Q-302 at the junction of C-345 and C-346.

The low frequency oscillator circuit is common to both receiver and transmitter. The oscillator operates on the fundamental mode of the crystals (13.5 MHz to 12.6 MHz in 0.1 MHz steps). Energy from the LFO is inductively coupled into the balanced mixer circuit. The balanced mixer circuit employs two transistors Q-301 and Q-302 in a symmetrical circuit to mix signals from the HFO DBLR and the LFO to produce the desired transmitter output frequency. This output frequency is the difference between two times the HFO and LFO. The output of the balanced mixer is inductively coupled via L-330 to the grid of the transmitter buffer tube V-5B.

The desired transmitter output frequency is amplified by V-5B, V-10 and V-11. These stages are coupled together and to the antenna by tracked pi-networks. A low pass filter, consisting of L-336, C-357, and C-359 attenuate harmonics of the transmitting frequency.

Modulation of the transmitter is accomplished by taking the audio signal from the microphone and amplifying it through the audio amplifier stages V-6A, V-5A, Q-401, and Q-402. High level plate modulation is applied to the final amplifier V-11 through the high impedance winding on transformer T-402.

Diode CR-401 and resistor R-415 are connected to the modulation winding of T-402 so that the percentage of modulation to the transmitter may be set below the 100% (80-85%) point providing modulation limiting.

Diode CR-401 and series resistor R-415 are connected between the low B + (+170 v) as reference and the transmitter end of the modulation winding. The diode is polarized such that it will start to conduct when the modulated B + swings below +170 volts thereby preventing the carrier from being completely shut off. The degree of limiting can be set by shunting across R-415 with a higher value of resistor, R-417, to obtain the desired limiting action.

3.5 OMNI/LOC CIRCUITS

3.5.1 OMNI Signal

In order to understand the circuits and purpose of the OMNI converter of the Mark 8, it is necessary to describe the signals being received. The OMNI station sends out one continuous VHF carrier wave with three simultaneous, but noninterfering amplitude modulations. These are:

1. VOICE MODULATION...200 to 2500 hertz (35% max. mod.).
2. REFERENCE PHASE SIGNAL. (30% mod.) 9960 hertz subcarrier frequency-modulated between 9480 and 10440 hertz with a fixed phase 30 hertz modulation.
3. VARIABLE PHASE SIGNAL...30 hertz (30% mod.) produced by rotating effectively a limacon antenna pattern 30 times per second at the station.

The variable phase signal is thus a 30 hertz sine wave modulation whose phase angle relative to the 30 hertz FM on the 9960 hertz subcarrier depends upon the bearing of the aircraft's receiving antenna to the station. The station is adjusted so that the variable phase signal is "in phase" with the reference phase at a bearing due magnetic north (0° mag.) from the station. Thus the receiver OMNI output signal contains the above three separate and distinct audio components which are mixed together in simple addition. It is the purpose of the OMNI converter circuits to reject the voice modulation, separate the other two components, and indicate, by means of a Bearing Selector/Indicator, the relative phase angle between the variable phase signal and the reference phase signal, as received, thus indicating the bearing to the station.

The "Voice Modulation" is used primarily for identification. It may also be used for communication when required.

3.5.1.1 OMNI Operation

The OMNI converter portion of the Mark 8 is divided into two channels, a Reference Phase channel and a Variable Phase channel.

The Reference Phase Channel consists of two stages, V-3A and V-9B. The signal from the receiver is injected into V-3A through a two section high pass filter. This stage, V-3A, is operating as a limiter and drives an FM discriminator involving T-202, CR-201, and CR-202. The detected 30 Hz signal is injected into the reference channel output amplifier (V-9B) through a low pass filter. The cathode voltage from V-9B is coupled into the L-R phase demodulator circuit for comparison with the variable phase signal. The plate voltage of V-9B is transformer coupled via T-203 into the T-F phase demodulator involving CR-204 and CR-206. This signal is rotated in phase 90 degrees by the transformer T-203 and the capacitor C-240.

The Variable Phase Channel consists of three stages, V-7A, V-8A, and V-4B. The first stage, V-7A, is a phase splitter whose outputs are coupled into the course selector, R-252. The output from this course selector is continuously variable through 360 degrees. This signal is amplified through the two stage, selective frequency, feedback amplifier consisting of V-8A and V-4B. The phase of the output signal can be shifted ± 10 degrees by adjusting the zero set potentiometer, R-214, in the feedback circuit to the grid of V-8A. The output from the amplifier (V-8A and V-4B) is transformer coupled via T-201 to the balanced phase demodulator involving CR-203 and CR-205.

3.5.1.2 Phase Demodulator (Metering Circuits)

The L-R circuit consisting of CR-203, CR-205, R-248, and R-247 will cause the zero center INDICATOR, M-201-A, to have zero deflection when the variable phase output signal and the reference phase output signal are 90 degrees out of phase.

The TO-FROM circuit consisting of CR-204, CR-206, R-249, and R-250 will cause the TO-FROM INDICATOR, M-201-B, to read full TO or FROM when the reference channel output is "in-phase" with one of the vector components from the center tapped, variable channel output transformer, T-201.

3.5.2 Localizer

3.5.2.1 Localizer Signal

The LOCALIZER signal received by the navigation receiver is a horizontally polarized signal radiated above the landing strip. The radiated signal appears as two narrow lobes which intersect over the runway. The right lobe is modulated by 90 Hz and the left lobe is modulated by 150 Hz. The 90 and 150 Hz signals are of equal amplitude along the center of the runway. The LEFT-RIGHT meter indicates the instantaneous location of the aircraft with reference to the center of the runway.

When the aircraft is located above the runway and the 90 and 150 Hz signals are equal, the indicator pointer moves to the center position. The TO-FROM indicator shows TO anytime a suitable localizer signal is received.

3.5.2.2 Localizer Circuit

The detected 90/150 Hz signal from the receiver section detector, CR-102, is amplified by V-7B, the localizer amplifier. The output of V-7B coupled to the feedback amplifier consisting of V-8A and V-4B, through a notch filter tuned to approximately 115 Hz. The notch filter will shift the phase of the 150 Hz signal approximately +45 degrees and the 90 Hz signal -45 degrees. The detected localizer signal is also amplified without phase shifting through V-9B. The two signals, i.e., the phase shifted signal and the original signal, are then compared in the phase demodulator circuits. The meter can be zeroed by adjusting R-226 which will shift the phase of the 90 and 150 Hz signals. A change in the amplitudes of the signals, one increasing, the other decreasing will cause a deflection in the L-R meter. This is caused by the vector resultant of the one signal to increase while the vector resultant of the other signal decreases.

3.5.3 Power Circuits

The power supply section uses two power transistors, Q-501 and Q-502, and a power transformer, T-501, in a circuit whose simplified operation is as follows: The instant primary voltage is applied (A +), because of the inevitable dissimilarity of the two transistors, more current will flow in one than in the other. This greater flow of current through the feedback windings of the power transformer induces a voltage on the transistors such that the conducting unit is driven into greater conduction and the other is held at cut-off.

Almost instantly the transformer reaches saturation. Thus having reached maximum flux density, there is no more induced voltage in the bias windings which are connected to the transistor circuitry. Therefore, the current through the conducting transistor decreases, and the bias voltage at opposite polarity is developed which cuts off this transistor and simultaneously causes the second transistor to conduct. The same procedure repeats with the second transistor. This switching action repeats at high speed (7KHz) and the resultant output voltage of T-501 is essentially a square wave.

A full wave bridge rectifier consisting of CR-502, CR-503, CR-504, and CR-505 in conjunction with the center tapped secondary of T-501 provides a simple means of obtaining a dual voltage output. Filtering of these DC voltages is easily accomplished because of the high frequency of the power supply.

TABLE 3.1 RECEIVER FREQUENCY CHART (See Section 3.2)

KK CORRELATION CRYSTALS

A. NAVIGATION CHANNELS

HFO Crystal XT. No.	Input Signal MHz	HFO Frequency MHz	2xHFO	HF IF MHz
301	108.0	62.76575	125.5315	17.5315
302	109.0	63.26575	126.5315	17.5315
303	110.0	63.76575	127.5315	17.5315
304	111.0	64.26575	128.5315	17.5315
305	112.0	64.76575	129.5315	17.5315
306	113.0	65.26575	130.5315	17.5315
307	114.0	65.76575	131.5315	17.5315
308	115.0	66.26575	132.5315	17.5315
309	116.0	66.76575	133.5315	17.5315
310	117.0	67.26575	134.5315	17.5315

Tenths MHz	LFO Crystal XT. No.	LFO Frequency MHz	LF IF MHz
.0	311	13.5315	4.0
.1	310	13.4315	4.0
.2	309	13.3315	4.0
.3	308	13.2315	4.0
.4	307	13.1315	4.0
.5	306	13.0315	4.0
.6	305	12.9315	4.0
.7	304	12.8315	4.0
.8	303	12.7315	4.0
.9	302	12.6315	4.0

For frequencies 108.0 thru 117.9 MHz

1. HFIF results from 2HFO-Input Signal i.e. for 108.1 MHz - 125.5315 - 108.1 = 17.4315 MHz
2. LFIF results from HFIF-LFO i.e. for 108.1, HFIF = 17.4315 and LFO = 13.4315 therefore LFIF = 17.4315 - 13.4315 = 4.0 MHz.

B. COMMUNICATIONS CHANNELS

HFO Crystal XT. No.	Input Sig. MHz	HFO freq. MHz	2xHFO	HF IF MHz
303	118.0	63.76575	127.5315	9.5315
304	119.0	64.26575	128.5315	9.5315
305	120.0	64.76575	129.5315	9.5315
306	121.0	65.26575	130.5315	9.5315
307	122.0	65.76575	131.5315	9.5315
308	123.0	66.26575	132.5315	9.5315
309	124.0	66.76575	133.5315	9.5315
310	125.0	67.26575	134.5315	9.5315
311	126.0	67.76575	135.5315	9.5315

Tenths MHz	LFO Crystal XT. No.	LFO Frequency MHz	LF IF MHz
.0	311	13.5315	4.0
.1	310	13.4315	4.0
.2	309	13.3315	4.0
.3	308	13.2315	4.0
.4	307	13.1315	4.0
.5	306	13.0315	4.0
.6	305	12.9315	4.0
.7	304	12.8315	4.0
.8	303	12.7315	4.0
.9	302	12.6315	4.0

For frequencies 118.0 thru 126.9 MHz

1. HFIF results from 2HFO-Input Signal i.e. for 118.1 MHz 127.5315 - 118.1 = 9.4315 MHz
2. LFIF results from LFO-HFIF i.e. for 118.1 MHz 13.4315 - 9.4315 = 4.0 MHz

TABLE 3.2 TRANSMITTER FREQUENCY CHART (See Section 3.2)

KK CORRELATION CRYSTALS

HFO Crystal XT. No.	Transmitter Output Freq Whole MHz	HFO Frequency MHz	2xHFO MHz
307	118.0	65.76575	131.5315
308	119.0	66.26575	132.5315
309	120.0	66.76575	133.5315
310	121.0	67.26575	134.5315
311	122.0	67.76575	135.5315
312	123.0	68.26575	136.5315
313	124.0	68.76575	137.5315
314	125.0	69.26575	138.5315
315	126.0	69.76575	139.5315
* 316	112.1	61.05	122.1

Tenths MHz Channels	LFO Crystal XT. No.	LFO Frequency MHz
.0	311	13.5315
.1	310	13.4315
.2	309	13.3315
.3	308	13.2315
.4	307	13.1315
.5	306	13.0315
.6	305	12.9315
.7	304	12.8315
.8	303	12.7315
.9	302	12.6315

Desired transmitter output frequency is accomplished by the following: 2xHFO - LFO = desired output frequency i.e. for 118.5 MHz Output Frequency.

2xHFO = 131.5315, LFO = 13.0315 therefore
131.5315 - 13.0315 = 118.5 MHz

* Crystal 316 is only activated when the receiver portion of the Mark 8 is being used on NAV channels (Refer to Section 3.1).

4.1 INTRODUCTION

This section containes the mechanical and electrical procedures necessary for proper maintenance and repair of the Mark 8. The mechanical procedures are given to the extent necessary for removal and replacement of mechanical parts, and for access to electrical components. The electrical procedures provide: overall operation check, receiver and transmitter adjustment procedure, the OMNI circuits, and PC board repair methods. All references to left, right, etc. locations refer to the Unit's installed position.

4.2 MECHANICAL ACCESS

4.2.1 Panel Unit Access

To remove the Mark 8 Panel Unit from its case it is necessary to disconnect the two antenna connectors and to disconnect the power and accessory connector extending from the rear of the Panel Unit. The Panel Unit is fastened to its case by a latch accessible thru a hole, in the front panel provided with a snap-in button cover. An Allen wrench is required to operate the latch. After turning the latch, the unit should be free for easy withdrawal.

4.2.2 Component Access

The design of the Panel Unit in a flat and shallow chassis is such that direct access to a large majority of the components is possible from above or below, as soon as the unit is removed from the case. When access is required to components on the front or rear panels or on the OMNI circuit board along the left side, the following subsections should be consulted.

4.2.3 Front Trim Panel Removal

See Figure 4-1.

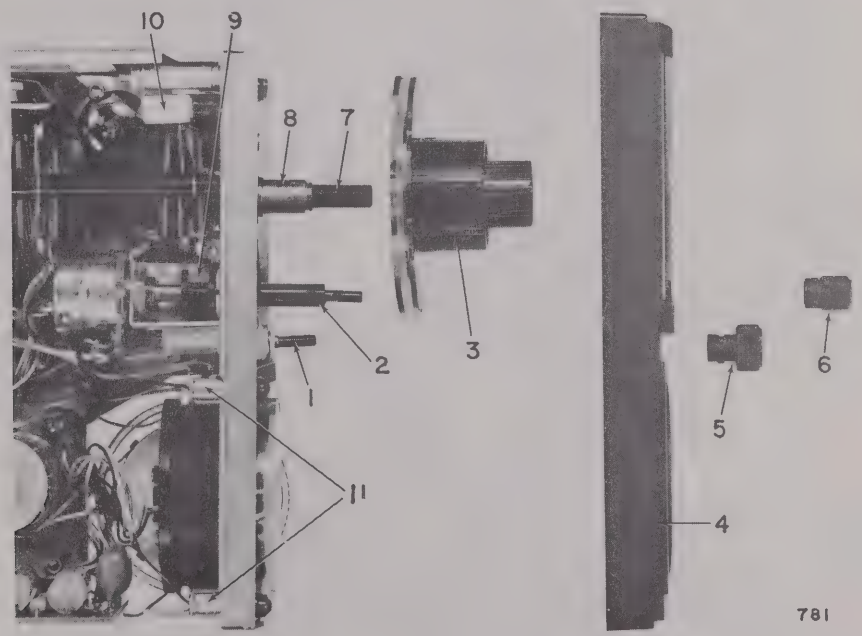
The front panel may be removed by proceeding as follows:

a. Remove the VOL and OBS knobs. Each one is fastened with two hex socket head setscrews.

b. Remove the four screws, two at each side of the panel.

c. The panel may now be pulled forward and off, without removing the Channel Selector knobs.

Procedure for removal and replacement of these items will be fairly obvious, except for the channel selector shafts. These will be covered in later paragraphs.



Item No.	Part No.	Description	Item No.	Part No.	Description
1	51688-1	PULLEY & SHAFT, OBS	6	88189-1	KNOB, IDENT/VOL
2	51682-1	SHAFT, IDENT/VOL	7	51640-1	SHAFT, KHZ
3	1931-468	MHZ/KHZ DIAL ASSY	8	1931-512	DETENT & SHAFT, MHZ
4	1931-302	TRIM PANEL ASSY	9	51681-1	BRACKET, IDENT/VOL
5	88191-1	KNOB, OBS	10	41278-3	LAMPHOLDER
			11	41278-4	LAMPHOLDER

Figure 4-1 FRONT TRIM PANEL REMOVAL (See Paragraph 4.2.3)

4.2.4 Rear Panel Access

Access to all components on the rear panel may be had without disconnecting any wires, after removing the eight screws holding the transistor shields and rear panel to the chassis and tilting the panel away from the chassis. Location and arrangement of the associated spacers and hardware should be noted to enable proper replacement. See Figures 4-19 and 4-20.

4.2.5 Left Side and OMNI Board Access.

When the Panel Unit is out of its case there is access to LOC/OMNI centering controls and test/compensation points on the OMNI circuit board as illustrated in Figure 6-1.

The left side frame may be removed without removing the front or rear panel. The procedure is as follows:

a. Remove two screws attaching the left transistor shield to the rear panel.
b. Remove two screws to the bracket behind the front panel.
c. Remove two screws to the horizontal chassis, along the lower side of the frame.
d. Remove three flat head screws along the top of the frame. Note that there are three insulating washers between the frame and the OMNI board.

The OMNI printed circuit board is attached to the chassis by three screws along the lower edge of the board. Note that when refastening the board, it is mounted on the inside of the metal tabs. Upon removal of the screws, the board can be folded down without disconnecting any wires. See Figure 4-2.

4.2.6 Right Side Access

Removal of the right side frame permits access to the channel selector crystal switching assembly.

The right side frame may be removed without removing the front or rear panel. The procedure is as follows:

a. Remove the two screws attaching the right transistor shield to the rear panel.
b. Remove the two screws to the bracket behind the front panel.
c. Remove the two screws to the horizontal chassis, along the lower side of the frame.

4.3 MECHANICAL MAINTENANCE

All moving parts are associated with the direct manual controls on the front panel. They do not normally call for routine maintenance. However, removal and replacement of the channel selector shafts may be required if trouble develops in the channel selector assemblies.

4.3.1 Channel Selector

The Channel Selector consists of two separate concentric manually operated assemblies. Either assembly may be rotated continuously in either direction, because there are no stops.

a. The Tenths Megahertz (MHz) Selector is operated by the small central knob, which is attached to a long ¼ inch diameter phenolic shaft. This shaft runs thru the hollow MHz shaft and operates the crystal selector switch section S-103 combined with L-307, and the combined S-202-A/S-202-B switch sections for the VOR/LOC function. These two sections are located to the rear of the crystal assembly and are driven by flats on the ¼ inch shaft. The Tenths MHz detent mechanism is at the rear of the switch sections. See Figure 4-3.
b. The Whole MHz Selector is operated by the large outer knob. This knob is attached to a hollow 3/8 inch OD phenolic shaft having flats, which drives a total of 13 variable inductor and switch sections and the crystal selector switch S-302. See Figure 4-3. The Whole MHz detent mechanism is on the front of the metal front subpanel. See Figure 4-5.

4.3.2 Tenths Megahertz Selector

In order to remove and replace either of the two switch sections driven by the Tenths MHz knob it is necessary to remove the ¼ inch dia. phenolic shaft. To do this proceed as follows:

a. Set the dial to the 0.0 Tenths MHz position.
b. Remove the front trim panel as outlined under 4.2.3.
c. The tenths MHz detent assembly is at the rear end of the tenths shaft. See Figure 4-3. Note the arrangement of the tenths detent assembly.
d. Loosen the two setscrews holding the detent "STAR" wheel, which is part of the tenths detent assembly.
e. Remove the shaft by pulling on the tenths MHz knob. The tenths detent assembly will fall free.

To replace the shaft, reverse the procedure.

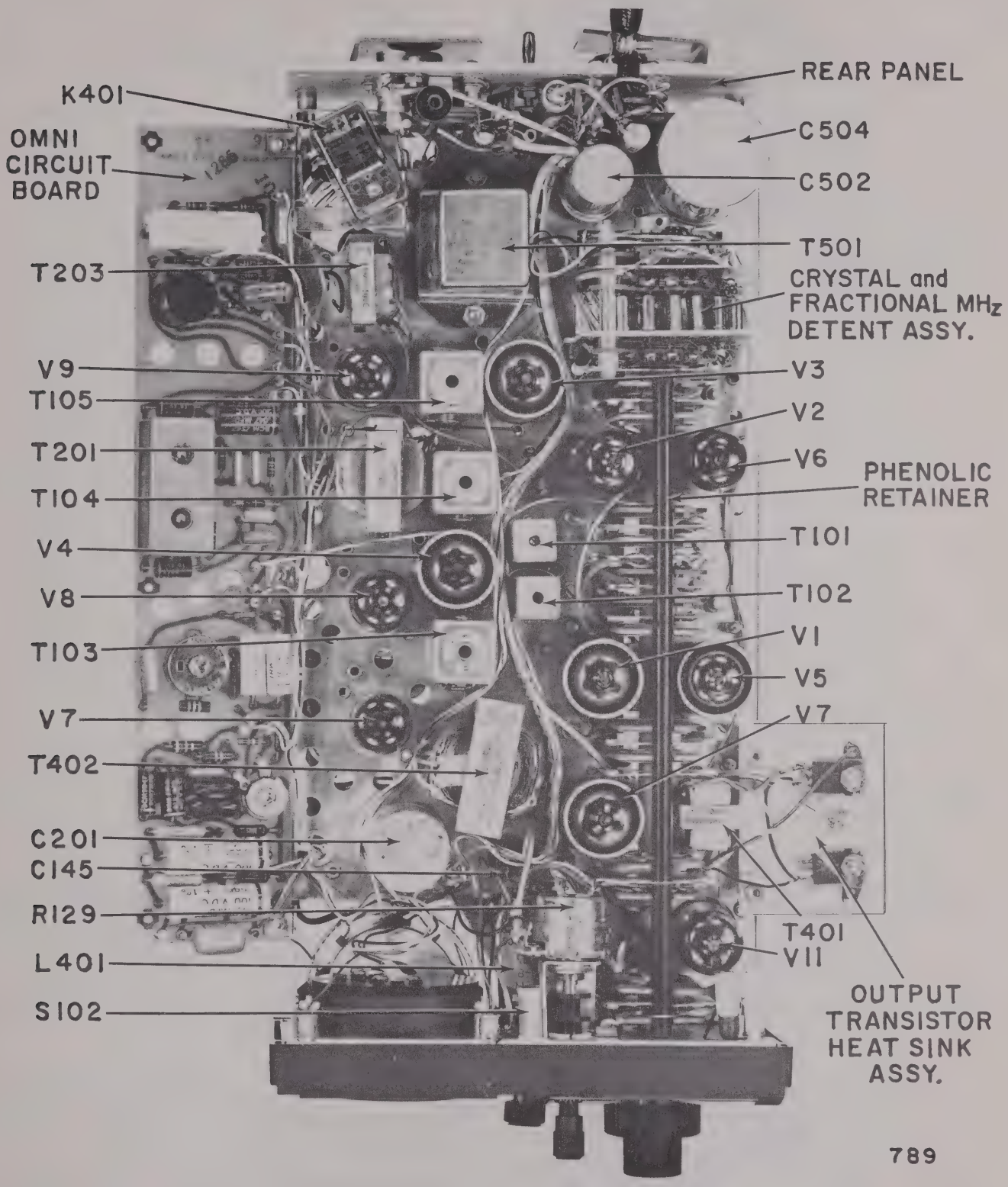
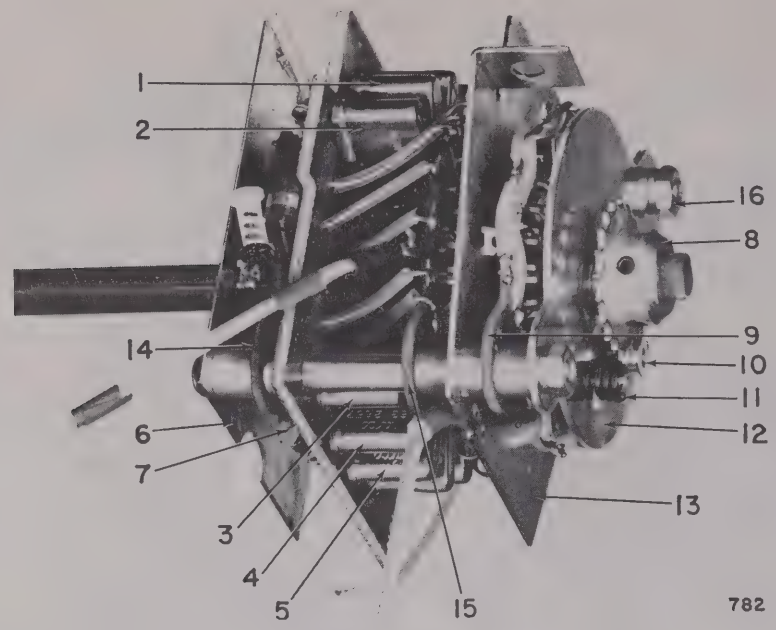


Figure 4-2 MARK 8, Top View, Sides Removed
(See Paragraph 4.2.5)



ITEM NO.	PART NO.	DESCRIPTION
1	72020-15	XT-315
2	72020-16	XT-316
3	72020-1	XT-301
4	72020-2	XT-302
5	72020-3	XT-303
6	51636-11	SHIELD FRONT
7	1931-550	CRYSTAL BOARD ASSY
8	51644-101	DETENT
9	1931-544	WAFER, KHZ
10	61401-1	ROLLER, DETENT
11	61402-1	SPRING, DETENT
12	61405-101	PLATE, DETENT
13	51634-1	SHIELD, REAR
14	1931-548	FRONT WAFER ASSY (S302)
15	1931-546	REAR CRYSTAL WAFER (L307/S103)
16	Hardware:	
	82900-8	NUT, HEXAGON
	81324-6	WASHER, LOCK
	82805-20	SCREW, MACHINE

Figure 4-3 CRYSTAL AND FRACTIONAL MHz DETENT ASSY. (See Paragraphs 4.3.1, 4.3.2, 4.3.4)

4.3.3 Whole Megahertz Selector

In order to remove and replace any of the variable inductors or switches driven by the whole MHz knob, it is necessary to remove the 3/8 inch OD phenolic shaft. To do this proceed as follows:

a. Set the dial to the 108 MHz position.

b. Remove the front trim panel as outlined under 4.2.3.

c. Loosen the two setscrews holding the Tenths MHz knob and remove it. Note that the Whole MHz shaft can be removed without removing the Tenths MHz shaft.

d. Loosen the two setscrews holding the Whole MHz knob and remove it.

e. Loosen and remove the two screws and associated hardware which hold the Whole detent assembly to the metal front subpanel. See Figure 4-5.

f. Remove the shaft by pulling on the Whole detent assembly. The Whole detent assembly will remain intact on the shaft.

To replace the shaft, reverse this procedure. Note, however, that the black phenolic retainer rod above the switch and inductor sections must be in position to permit replacing the shaft without difficulty.

4.3.4 Quartz Crystals

All 16 Quartz frequency control crystals XT-301 thru XT-316 are assembled on a printed circuit board between the two switch sections S-302 and L-307/S-103. See Figure 4-3.

The crystals are of the wire-in type. Removal and replacement must be done carefully. The procedure is to disconnect the lead to S-302 first, and then, using printed circuit techniques, disconnect both leads from the printed circuit board. For details concerning printed circuit methods refer to Section 4-9.

4.3.5 Reference Marks and Positions

All mechanical position references are as viewed looking at the front panel in an upright position.

a. Tenths MHz Shaft.
When the Selector is in the 0.0 MHz position the flats on the rear end of the ¼ inch shaft are in a plane 18° counterclockwise from the vertical.

The shaft should extend beyond the rear of the Tenths detent "STAR" bushing by about 1/16 inch.

b. Tenths MHz Switch Sections.
The switch section rotors S-301/L-307 and S-202-A/S-202-B have reference notches on one side of the "double D" cutout for the ¼ inch shaft. These reference notches are on the right hand flat when the selector is in the 0.0 Tenths MHz position. A further check on the S-103/L-307 section may be made by observing that the rotor contact is on the stator contact at the top left to which a small coax cable is connected, when the Selector is in the 0.0 Tenths MHz position.

c. Whole MHz Shaft.
When the selector is in the 108 MHz position the flats on the 3/8 inch OD shaft are in a vertical plane.

d. Whole MHz Variable Inductors and Switches.
Each of these inductor and switch section rotors has a reference notch on one side of the "double D" cutout for the 3/8 inch OD shaft. These reference notches are on the right hand flat when the selector is in the 108 MHz position.

4.3.6 Whole MHz Switch and Inductor Sections

The first 13 sections driven by the MHz Selector knob are retained by a notched black phenolic rod which must be removed to remove a switch section. To remove this retainer rod proceed as follows:

a. Remove the "Truarc Retainer" on the front of the metal front subpanel, near the panel lamp. See Figure 4-5.

b. Remove the two retainer springs at the top of the second and eighth vertical metal shields. See Figure 4-4.

Note that the 3/8 inch OD shaft should be removed before removing the retainer rod and be replaced after the retainer rod is back in position, to avoid difficulty. The removal and replacement of a particular section will depend on its connections. The procedure must be determined by inspection.

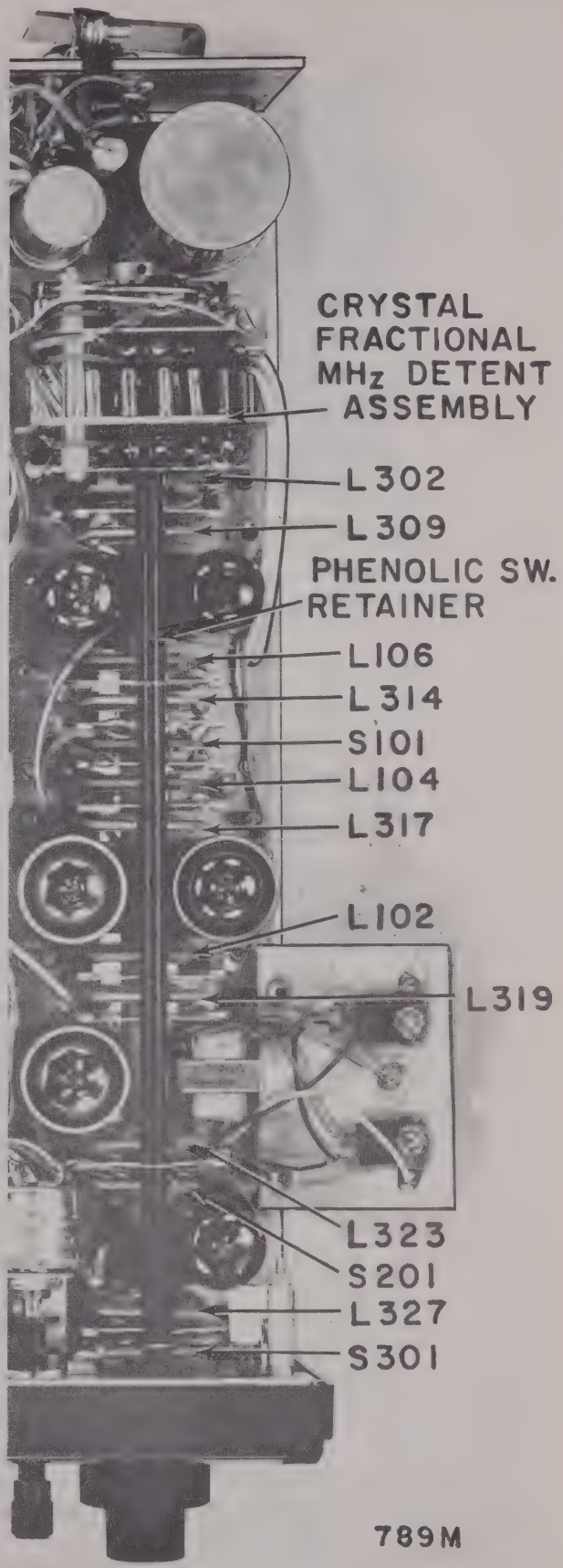
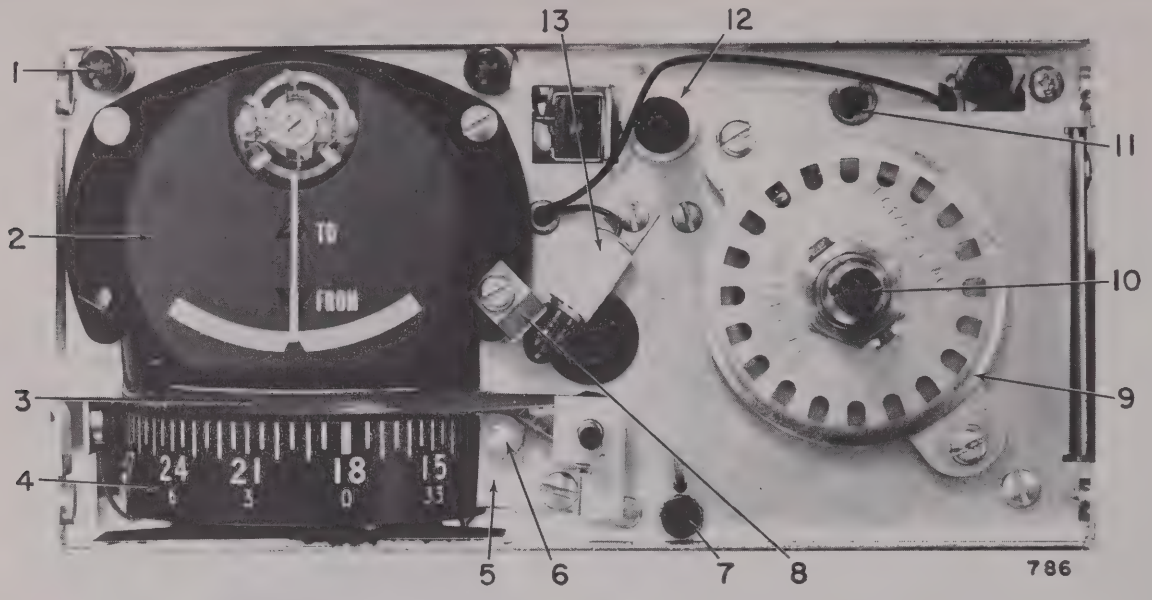


Figure 4-4 SWITCH AND INDUCTOR SECTIONS (See Paragraph 4.3.6)



Item No.	Part No.	Description	Item No.	Part No.	Description
1	12000-15	LAMP (Qty 4)	8	50697-1	SHIELD, LIGHT
2	76065-2	L-R/TO-FROM METER	9	1931-512	MHZ DETENT & SHAFT ASSY
3	54960-3	BELT, GEAR	10	51640-1	SHAFT, KHZ
4	1931-220	OBS DRUM ASSY	11	81192-7	RETAINER, TRUARC
5	51698-1	BRACKET, OBS DRIVE	12	84049-8	BEARING, NYLON
6	51691-1	GUIDE, BELT	13	41278-3	LAMPHOLDER
7	54978-1	SCREW, CAPHEAD			

Figure 4-5 MARK 8 WITH TRIM PANEL ASSY. REMOVED (See Paragraphs 4.3.1, 4.3.3, 4.3.6)

4.4 ELECTRICAL MAINTENANCE

4.4.1 Equipment Required

a. RF Power Wattmeter, Bird Termaline Model 61, or equivalent.
b. DC Vacuum Tube Voltmeter (DC VTVM), RCA Senior Voltohmyst, with WG-301A Crystal Diode Probe, or equivalent. Do not use for OMNI measurements.
c. AC Vacuum Tube Voltmeter (AC VTVM), Ballantine Modle 300 or equivalent for OMNI measurements.
d. Low Impedance Microphone, with "push-to-talk" button.
e. MF/HF Signal Generator, General Radio Model 1001-A, or equivalent.
f. VHF Signal Generator, Hewlett-Packard Model 608-D, or equivalent.
g. Audio Wattmeter, General Radio Type 583-A, or equivalent.
h. Low Voltage DC Supply, 12-15V., dc at 10 to 15 amperes, Electro Products Laboratories, Model NFB, or equivalent.
i. Omni Signal Generator, Aircraft Radio Corporation, Model H-14A, or equivalent.
j. For phase angle measurement, three additional pieces of equipment are required, as indicated in Figure 4-6.

4.5 OVERALL OPERATING CHECK

4.5.1 Receiver

Procedure: See Figure 4-21.

a. Connect the audio output (5 watts full scale), meter to the output cable Pins 4 and 8 on J-401/P-401.
b. Connect the AC VTVM to TL-20, terminal No. 5 (2 VAC full scale). Refer to Figure 4-7 (Junction R-124 and C-137).
c. Connect the VHF Signal Generator to the antenna connector J-101. Set the Signal Generator for a 108.0 MHz thru 126.9 MHz range, with 1000 Hz, 30% modulation.

Normal Indications:

d. A signal of 3.5 μv maximum should produce a detector output of 1.3V RMS and 4.0 watts minimum (volume control at maximum) on all NAV channels.
e. A signal of 6 μv maximum should produce a detector output of 1.3 V RMS and 4.0 watts minimum (volume control at maximum) on all COM channels, or 100 milliwatts (1 set phones. 600 ohms).

f. A signal of 1.5 μv maximum should produce 6 db signal plus noise to noise at the speaker output in all NAV channels.
g. A signal of 2.5 μv maximum should produce 6 db signal plus noise to noise at the speaker output on all COM channels.
h. Set the Low Voltage DC supply to 12.0 vdc. Increase output from VHF signal generator to approximately 100 μv. All receiver channels should operate.
i. If normal indications are not obtained, refer to the procedures outlined in the paragraphs under Section 4.6.

4.5.2 Transmitter

NOTE

TRANSMITTER ALIGNMENT CHECK SHOULD BE MADE IN A CASE OR THE EQUIVALENT OF THE LOWER HALF OF THE CASE. THIS IS NECESSARY DUE TO THE PROXIMITY OF THE CASE TO THE TRANSMITTER CIRCUITS.

Procedure: See Figure 4-21.
a. Refer to the Transmitter/Power Supply/Audio Block Diagram, Figure 3-2.
b. Connect the RF Wattmeter to J-301, the transmitter antenna connector, in place of the antenna.
c. Place the Channel Selector on any COM channel, 118.0 thru 126.9 MHz.
d. With the "Push-to-talk" microphone connected, activate the transmitter.
e. Check all transmitter channels over the complete range of 118.0 thru 126.9 MHz.
f. Set the Low Voltage DC supply to 12.0 vdc. Depress mike button, a slight amount of RF output should be noted on all channels. No specified power output at low line.

Normal Indication:

Power output should be a minimum of 2 watts on all channels without modulation. Voice modulation should cause a slight increase in the output power.

If a normal indication is not obtained, refer to the procedures outlined in the paragraphs under Section 4.7.

4.5.3 OMNI and Localizer Circuits

Procedure. See Figure 4-21.

a. Connect the test equipment to the receiver.
b. Set the receiver Channel Selector dial to an OMNI channel.
c. Set the RF Signal Generator output at 500 microvolts. Set the OMNI course selector at 270° with with the modulation switch on the OMNI position.
d. Set the receiver course selector dial to 270°. The Left-Right needle should read center, and a full "TO" flag should show. Rotate the OMNI signal generator to 90° and note any LEFT-RIGHT needle swing. Full "FROM" flag should show.
e. Check course selector heading against OMNI Signal Generator headings. They should agree within 4°.
f. A 500 μv signal should produce a course width (edge-to-edge color sector) of 18° minimum to 26° maximum.
A 4.5 μv OMNI signal should produce a course width of approximately 50°.
g. Set OMNI signal generator for localizer signal output. Set the receiver dial for an odd tenth megahertz channel 108.1 thru 111.9.
h. Check centering of LEFT-RIGHT needle. A change of 4 db localizer signal will give deflection to the edge of the color sections.

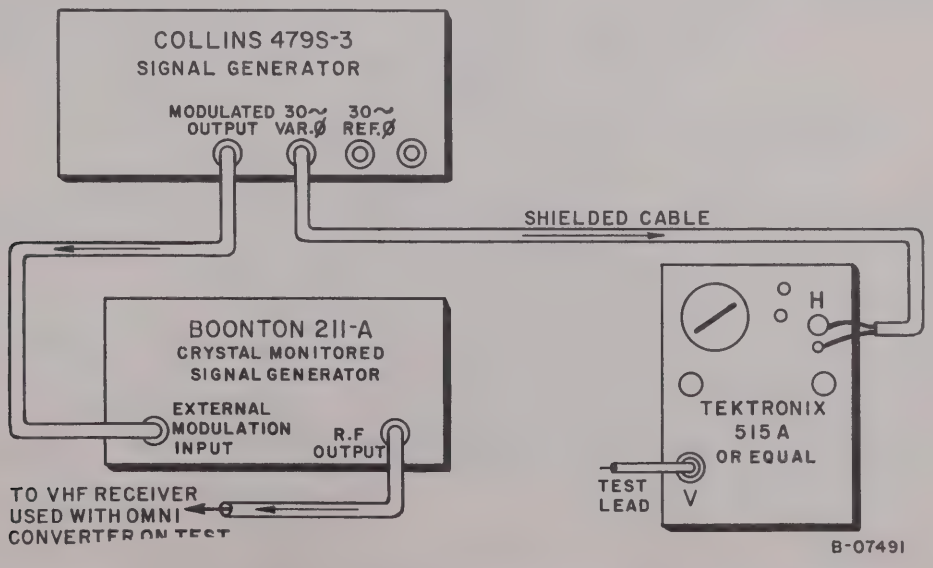


Figure 4-6 TYPICAL TEST SETUP FOR PHASE ANGLE MEASUREMENT (See Paragraph 4.4.1)

4.6 RECEIVER ADJUSTMENT PROCEDURES

4.6.1 High Frequency Oscillator (HFO)

Connect the DC VTVM through a 1 meg resistor to Pin 9 of V-2B. The drive at Pin 9 of V-2B should be -3.0 VDC minimum. If it is less, select 126 MHz and peak L-301 for maximum negative voltage, then select 118 MHz and peak C-304 for maximum negative voltage. Repeat the procedure until the drive is approximately flat across all MHz channels. See Figure 4-7.

4.6.2 Low Frequency Oscillator (LFO)

Connect the DC VTVM thru a 1 meg resistor to Pin 9 of V-3B. The drive at Pin 9 of V-3B should be -2.0 VDC minimum on any Tenths MHz channel. If it is less, select the 0.0 channel and peak L-329 for maximum negative voltage. The remaining Tenths MHz positions 0.1 thru 0.9 should then be in tune.

4.6.3 Intermediate Frequency (IF) Alignments

In the following several alignment procedures, the results of the signal inputs and tuning procedures will be observed on the AC VTVM connected at the junction of R-124 and C-137. This is the output of the detector CR-102, at TL-20, terminal No. 5. See Figure 4-7 and the Schematic, Figure 6-2.

4.6.4 Low Frequency IF

Disconnect all components from Pin 9, V-8B, the grid of the second mixer. Connect the MF-HF Signal Generator to Pin 9, V-8B. Terminate the generator with a 47 ohm resistor and feed the grid through a .047 μf capacitor. A 4.0 MHz signal at 200 μv, 400 Hz, 30% modulation should produce 1.3 volts ac at the detector. If it does not, check the tuning of the LF IF transformers T-103 through T-105. Tune the primary and secondary slugs of all transformers for maximum output at the detector, CR-102. Make sure all cores are on the outer peak (See Figure 4-7).

Reconnect all components to Pin 9, V-8B.

4.6.5 NAV High Frequency IF

(See Figure 4-8).

a. Set the Channel Selector to 108.5 MHz.

b. Disconnect all components from Pin 2, V-2A and connect the Signal Generator to Pin 2. Terminate the generator with a 47 ohm resistor and feed the grid through a .047 μf capacitor. (Refer to Crystal Frequency Table 3-1.) Note the HF IF Frequency for the 0.5 MHz channel.

c. Set the MF/HF Signal Generator to the selected frequency. A level of 50 μv (400 Hz, 30% modulation) should produce approximately 0.5V. ac at the detector output, CR-102.

d. Now set the Tenths MHz dial to the 0.0 channel. Set the generator to the proper frequency and peak the primary and secondary of T-101 by adjusting the cores for maximum output at the detector, CR-102.

e. Reset the Tenths MHz dial to the 0.9 channel. Reset generators to the proper frequency and again repeak for maximum output at the detector, CR-102.

f. Check the output at the 0.0, 0.5, and 0.9 MHz points. Output at the 0.0 and 0.9 MHz points should be approximately the same. Output at the 0.5 MHz channel should be about 1 db below the end point values.

4.6.6 COM High Frequency IF

a. Set the Channel Selector to 118.5 MHz and repeat steps c., thru f., under 4.6.5., using the proper HF IF and adjust T-102 to obtain approximately flat output across all Tenths MHz channels. See Figure 4-8.

b. Reconnect all components to Pin 2, V-2A.

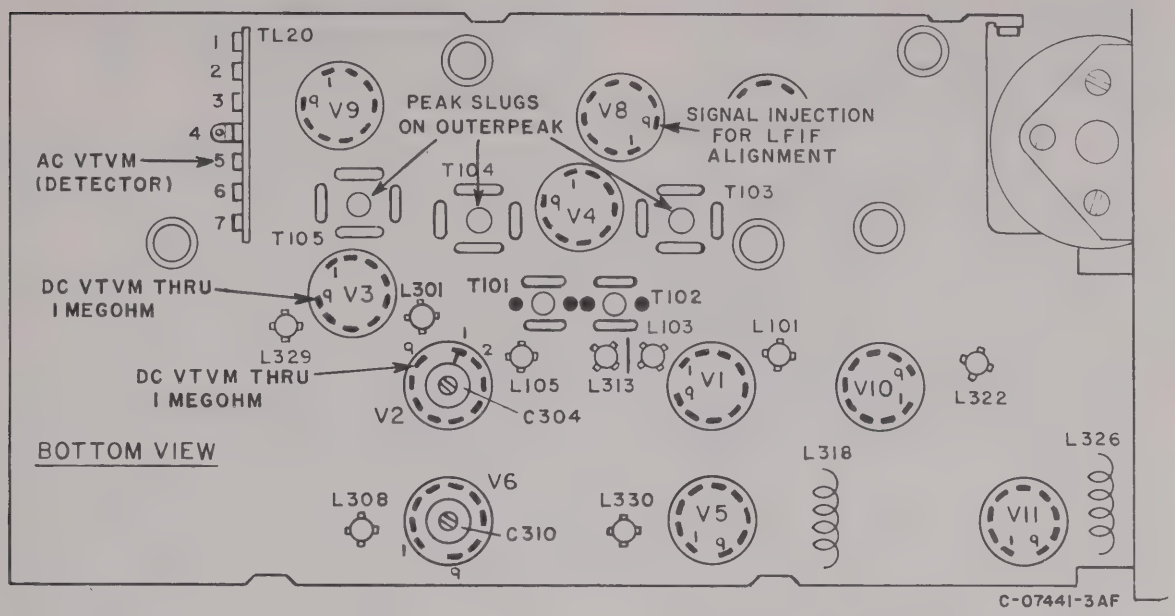


Figure 4-7 OSCILLATOR AND IF TEST CONNECTIONS
(See Paragraphs 4.5.1, 4.6.1, 4.6.3, 4.6.4, 4.7.1)

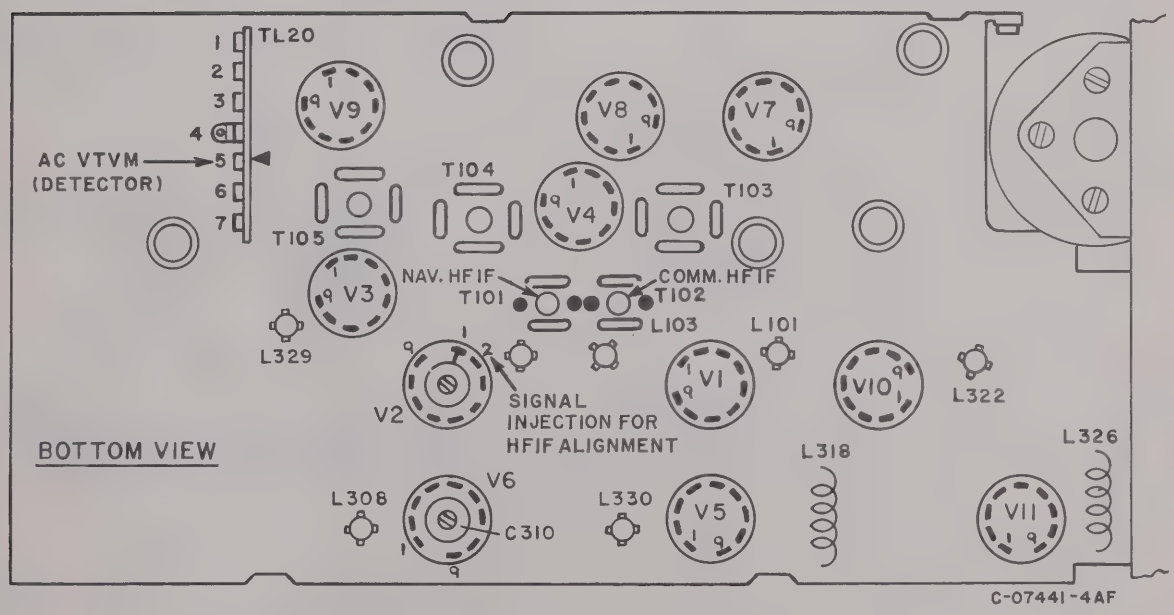


Figure 4-8 HF IF TEST CONNECTIONS (See Paragraphs 4.6.5, 4.6.6)

4.6.7 RF Amplifier and Mixer Circuits

Connect the test equipment as described in 4.5.1, steps a., b., and c. Refer to Figures 4-10 and 4-11 for location of alignment controls and proceed as follows:

a. Set the Channel Selectors and Signal Generator frequency selector to 126.5 MHz (6.0 μv input level).
b. Peak L-105, L-103, and L-101 for maximum output at the VTVM and/or the audio output meter.
c. Repeat step b. in the same order since there is some interaction between these circuits.
d. Set the Channel Selectors and the Signal Generator frequency selector to 108.5 MHz (6.0 μv input).
e. Peak C-108, C-105, and C-139 for maximum output at the VTVM and/or the audio output meter.
f. Repeat step e. in the same order since there may be some interaction between these circuits.
g. Set the Channel Selectors and the Signal Generator frequency selector to 126.5 MHz and repeat step b. and c. since there may be some interaction between the low and high ends of the band.
h. Set the Channel Selectors and the Signal Generator frequency selector to 108.5 MHz and repeat steps e. and f.

4.6.8 Audio Circuits

As noted in Section 4.5, a signal of 6 micro-volts to the input of the receiver should produce an audio signal of 1.3 volts at the output of the detector, CR-102, on all COM Channels. With the receiver volume control at maximum the 6 μv input signal should provide a 0.15 volt signal at the grid of the first audio amplifier V-6A, terminal 2 measured with an AC VTVM. This should provide a signal of 1.5 volts at the grid of the audio driver V-5A terminal 9. See Figure 4-12.

The output of V-5A is approximately 23 vac across the primary of T-401 (red & blue) (Pin 1 to ground). This should produce about 7.5 vac at the bases of Q-401 and Q-402. With this signal level present the output to the speaker (4 ohms) should be 4 watts minimum.

4.6.9 Automatic Gain Control (AGC)

The AGC threshold is that point at which the AGC line starts to go negative as a result of a signal increase.

It may be measured at TL-20, Terminal 3. See Figure 4-12.

The AGC line should start to go negative when the detector, CR-103, output level reaches 1.3V., ac ± 0.1 VAC. The detector output level may be measured at the junction of R-124 and C-137, which is located on TL-20, Terminal 5.

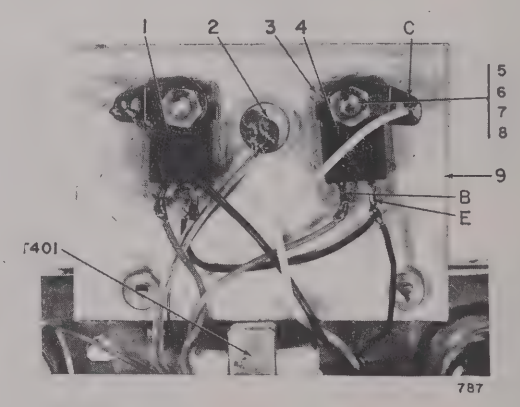
The AGC threshold is controlled by the value of R-117. One end of the R-117 may be located on TL-20, Terminal 3.

The AGC characteristic is such that a change of signal input level from 10 μv to 10,000 μv should produce a maximum of 4 db increase in the audio output signal.

4.7 TRANSMITTER ADJUSTMENT PROCEDURES

4.7.1 High Frequency Oscillator (HFO)

Connect the DC VTVM through a 1 meg ohm to pin 9 of V-6B. (See Figure 4-7) refer to the Schematic Diagram, Figure 6-3. The drive at the grid of V-6B, Pin 9, should be -3.0 vdc minimum on all COM MHz channels. If it is less, select 126 MHz and peak L-308 for maximum voltage. Then, select 118 MHz and peak C-310 for maximum voltage. Repeat this procedure until the drive is approximately flat over all MHz channels. Rotate the channel selector to any navigation frequency (108.0 thru 117.9 MHz). Activate the transmitter, and observe oscillator grid drive. If no drive voltage is present, or is very low, adjust the small airwound coil L-331 by compressing or spreading the turns until maximum drive voltage is obtained.



Item No.	P/N	Description	Item No	P/N	Description
1	75576-1	TRANSISTOR, AUDIO	5	82815-5	SCREW, MACHINE
2	31205-2	THERMISTOR (100 ohm)	6	81335-8	SPACER, SHOULDER
3	no number	INSULATOR, MICA (supplied with transistor)	7	81702-6	LUG, INT. TOOTH
4	75576-1	TRANSISTOR, AUDIO	8	82900-8	NUT, HEXAGON
			9	51683-1	HEAT SINK, AUDIO

Figure 4-9 OUTPUT TRANSISTORS /HEAT SINK ASSY.

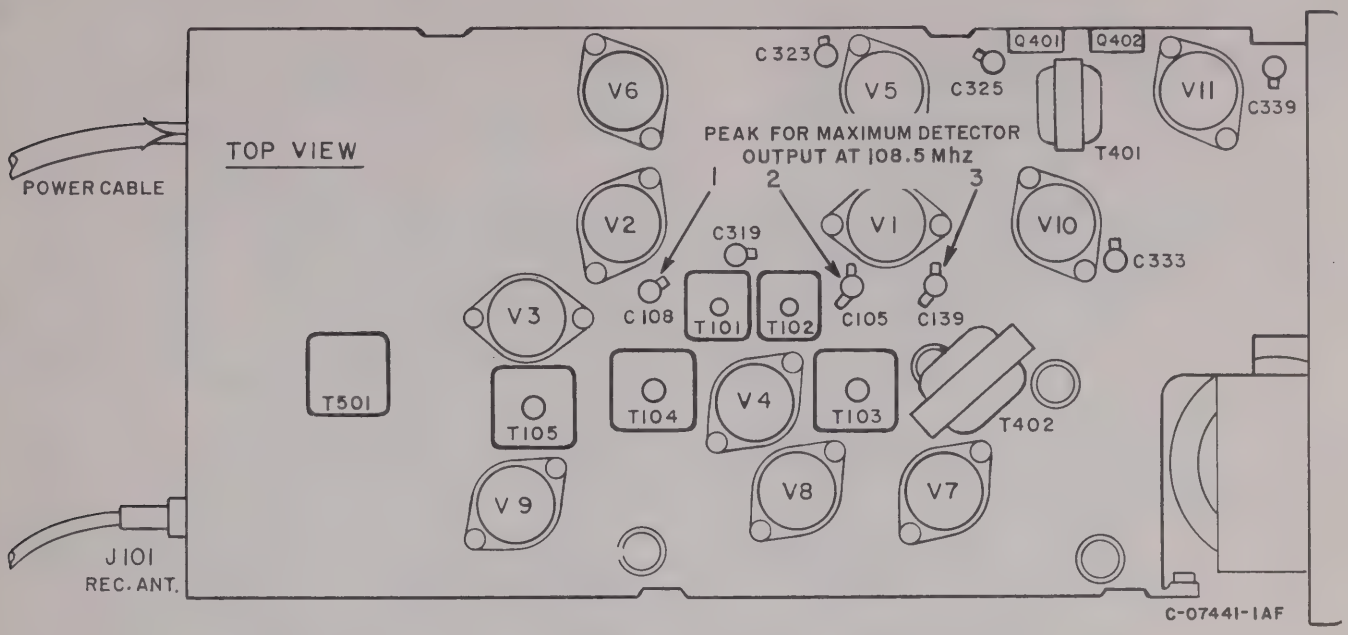


Figure 4-10 RECEIVER RF ALIGNMENT (See Paragraph 4.6.7)

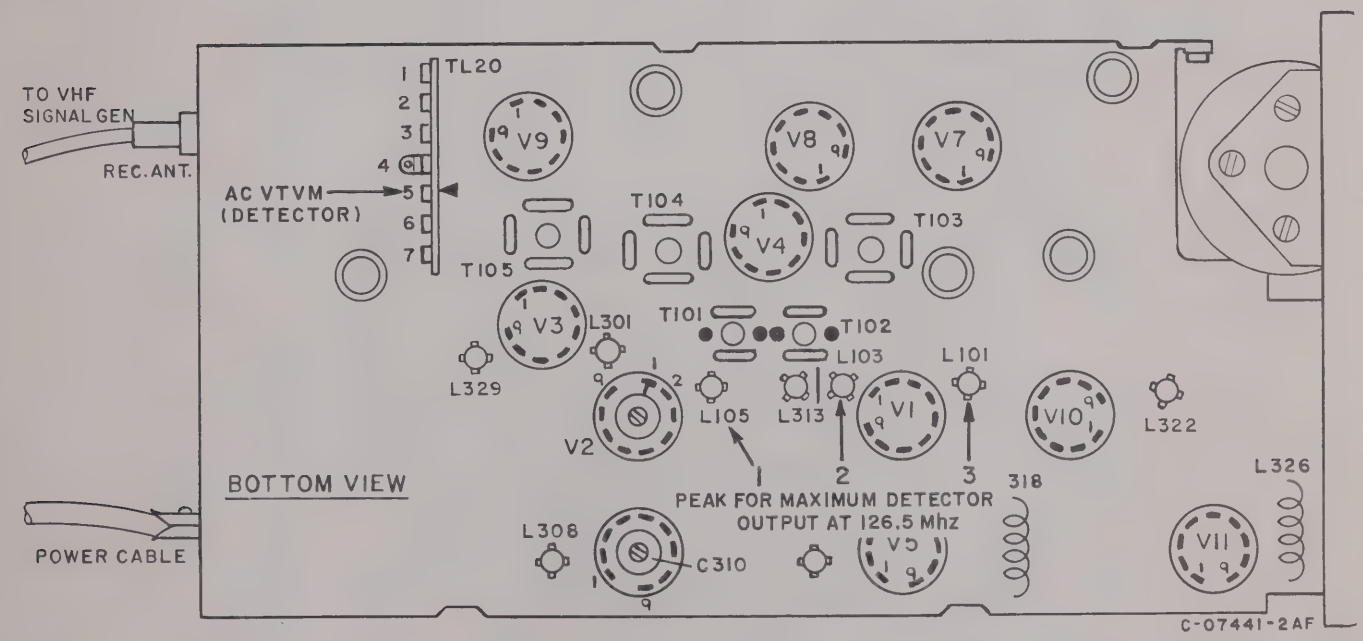


Figure 4-11 RECEIVER RF ALIGNMENT (See Paragraph 4.6.7)

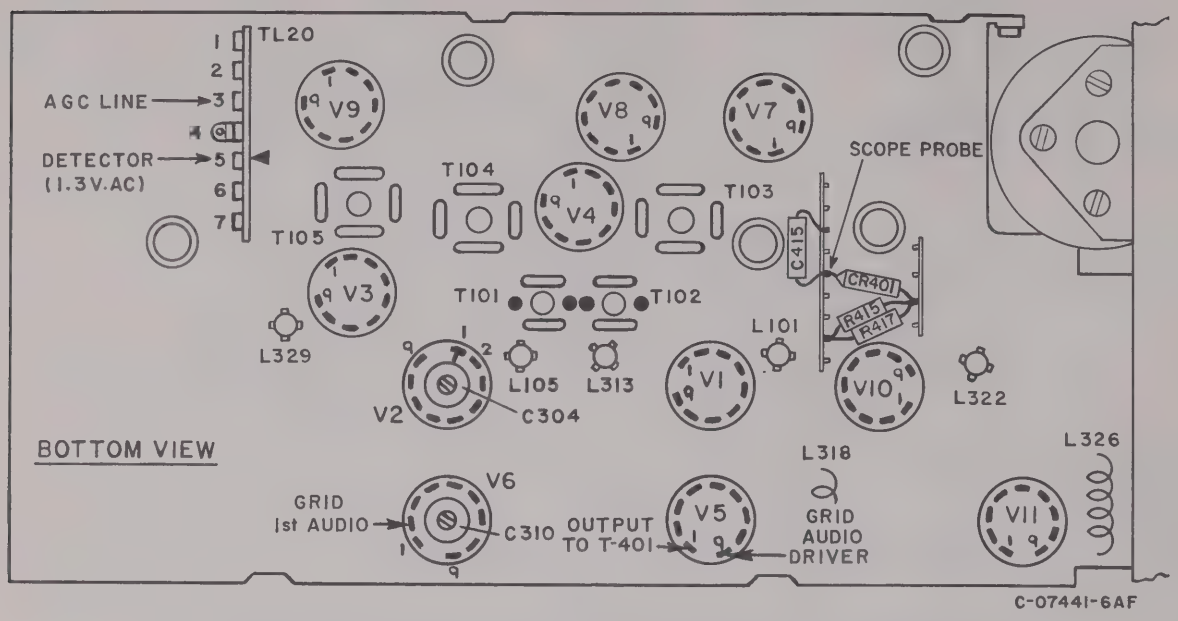


Figure 4-12 AUDIO AND TRANSMITTER ALIGNMENT
(See Paragraphs 4.6.8, 4.6.9, 4.7.8)

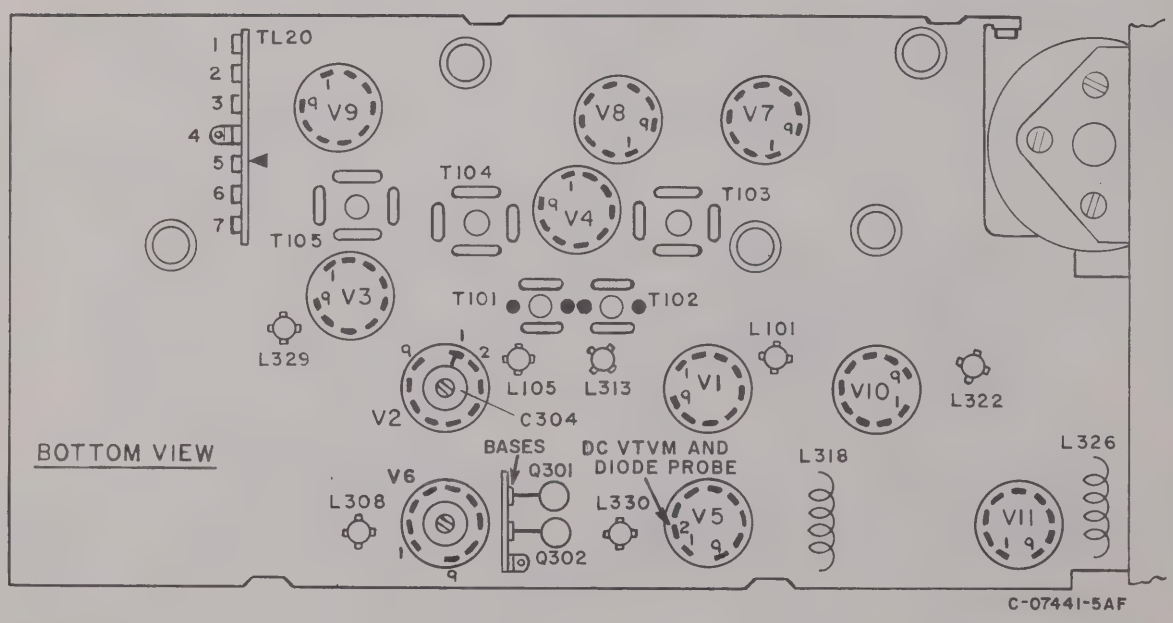


Figure 4-13 TRANSMITTER ALIGNMENT (See Paragraphs 4.7.2, 4.7.5)

4.7.2 High Frequency (HF) Doubler

The RF voltage at the grid Pin 9 of the HF Doubler V-1B should be approximately 3 volts RMS. It may be measured with the DC VTVM and its Diode Probe. See Figure 4-13.

4.7.3 Low Frequency Oscillator (LFO)

Refer to paragraph 4.6.2 for tune-up procedure.

4.7.4 Balanced Mixer

The Balanced Mixer, Q-301 and Q-302, receives energy from both the transmitter HF Doubler, V-1B, and the common LFO, V-3B. Energy levels from the HF Doubler and LFO are quite low. They can be measured with the DC VTVM and its Diode Probe.

a. To measure the level from the LFO, deactivate the HF Doubler by removing the tube V-6. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.15 volt RMS.
   If the voltage is too low the adjustment of L-313 should be peaked at 126.5 MHz and C-319 should be peaked at 118.5 MHz. See Figure 4-14 and 4-15. These adjustments should be repeated until the RF level is approximately uniform over the tuning range.

   Replace V-6 as soon as the measurement is completed.

b. To measure the level from the HF Doubler, deactivate the LFO by removing the tube V-3. The voltages at the bases of Q-301 and Q-302 should be alike and approximately 0.25 Volt RMS.

   Replace V-3 as soon as the measurement is completed.

c. The combined voltages from the LFO and the HF Doubler at the bases of Q-301 and Q-302 should be alike and approximately 0.5 Volt RMS.

4.7.5 Buffer

The buffer stage, V-5B, receives its grid drive from the output of the Balanced Mixer, Q-301 and Q-302. This drive is at the desired transmitter output frequency, but at a low level. It may be measured with the DC VTVM and its Diode Probe, at Terminal 2 of V-5B. The voltage should be about 1.0 Volt RMS.

If the voltage is too low, L-330 should be peaked at 126.5 MHz and C-323 at 118.5 MHz. See Figure 4-13. These adjustments should be repeated until the RF level is approximately uniform over the tuning range.

NOTE: Allowance should be made for some loading effect of the probe connection. This may be done by rechecking the peaking with the probe connection on the driver grid (V-10, terminal 7).

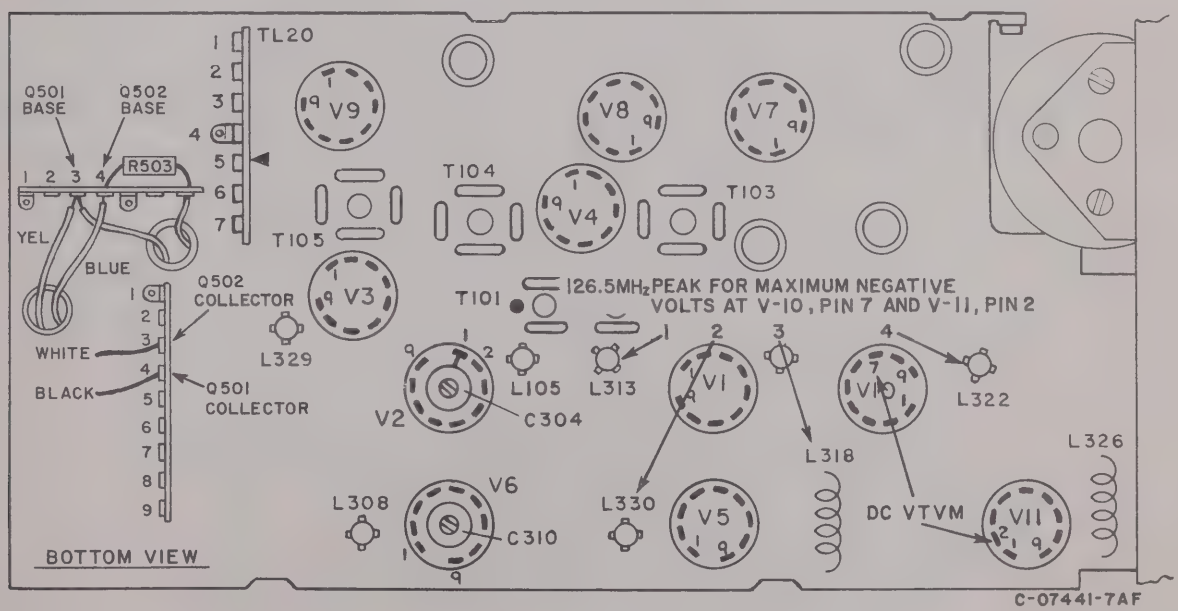


Figure 4-14 TRANSMITTER ALIGNMENT (See Paragraph 4.7.4)

4.7.6 Driver

The voltage at the grid of the driver, V-10, pin 7, should be -0.3 vdc minimum. If it is less, proceed as follows:

a. Select the 0.5 MHz position on the Tenths MHz Selector.
b. Select the 126 MHz position on the Whole MHz Selector and peak L-313, L-330, and L-318 for maximum negative volts at Pin 7 of V-10 (through a 1 megohm resistor).
   L-318 peaked by spreading or compressing coil.
c. Select the 118 MHz position on the Whole MHz Selector and peak C-319, C-323, and C-325 for maximum negative volts at Pin 7, V-10.
d. Repeat the above procedure until the drive is approximately flat across all MHz channels.

4.7.7 Final Amplifier

The drive at junction of L-325, R-321, R-330, and C-352 should be at least -35 vdc. If it is less, select the 126 MHz channel and peak L-322 for maximum negative volts at the junction of these components. Then, select the 118 MHz channel and peak C-333 for maximum negative volts. Repeat the procedure until the drive is approximately flat across all channels.

Peak for maximum power output at 126 MHz by spreading or compressing coil L-326. Peak C-339 for maximum power output at 118 MHz.

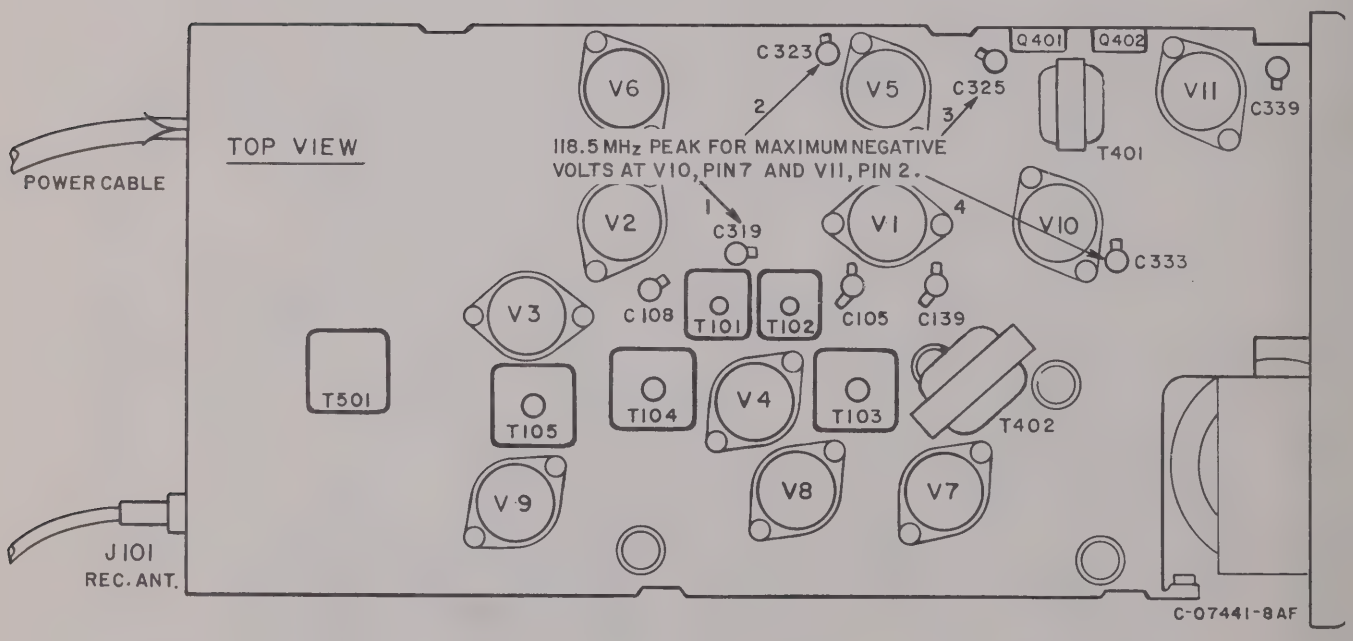


Figure 4-15 TRANSMITTER ALIGNMENT (See Paragraph 4.7.4)

4.7.8 Modulator

The transmitter final output amplifier V-11 a type 7701 tube, is modulated by the common push-pull Audio Amplifier/Modulator through a high impedance winding on the output transformer, T-402.

The audio voltage from the microphone (0.25 vac) is coupled to the grid (pin 2) of the first audio stage, V-6A through C-407. The gain through V-6A should produce about 1.5 vac at the grid of the audio driver, V-5A. The gain of V-5A should in turn, provide about 23 vac across the primary winding of T-401 driver transformer.

With the above conditions, the audio voltage across the modulation winding should be approximately 180 vac or about 5 watts of modulation power. A circuit consisting of diode CR-401 and series resistor R-415 is included to provide a means for modulation limiting. CR-401 and R-415 are connected between the low B+ line (+175) as reference and the transmitter end of the modulation winding. The diode is polarized such that it will start to conduct when the modulated B+ (+320) swings below +175 volts thereby preventing the carrier from being shut off. The degree of limiting can be set by shunting across R-415 with a higher value of resistor (R-417).

The modulation percentage of the transmitter can be checked or set in the following manner: See Figure 4-12.

a. Connect a DC coupled scope (vertical calibration 100 v/cm) between the junction of CR-401/C-415, and ground. With the Mark 8 running and the transmitter keyed, measure the unmodulated B+ voltage (approx. 320 vdc).
b. Modulate the transmitter by either whistling into the microphone or applying a 1000 Hz tone at approximately 0.1 vac level at the microphone input. Observing the waveform on the scope graticule for 85% modulation, the B+ peaks should rise to approximately 600 v and the negative peaks should not go below 50 v (above ground reference). See Figure 4-16.
c. If the negative peaks are less than 50 v, the value of the shunting resistor, R-417, should be lowered to allow greater current flow through diode, CR-401, and raise the minimum voltage to 50 v.

4.7.9 Navigation Transmitter Alignment

After the transmitter is completely aligned, rotate the channel selector to a navigation channel. Continue to monitor the final grid drive as in 4.7.7. If the drive is low or nonexistent, adjust airwound coils L-332, L-333, L-334, and L-335 in the order listed to obtain proper drive at the amplifier. These small coils will be found connected across the bottom of the transmitter step inductors.

Rotating the Channel Selector through all the navigation channels should produce a power output which is equal to or slightly greater than the output power obtained through the communications band (118.0 thru 126.9 MHz).

4.7.10 Transmitter In-Case Alignment

BEFORE INSTALLING THE UNIT IN THE AIRCRAFT, the transmitter tuning should be readjusted with the unit in a case, or the equivalent of the lower half of the case. This is necessary due to the proximity of the case to the transmitter circuits. The bottom of the case, or its equivalent, should be modified with a small access hole over each of the transmitter coils. The transmitter should be checked over all channels to insure proper operation. The unit may then be removed from the tune-up case and placed in the aircraft.

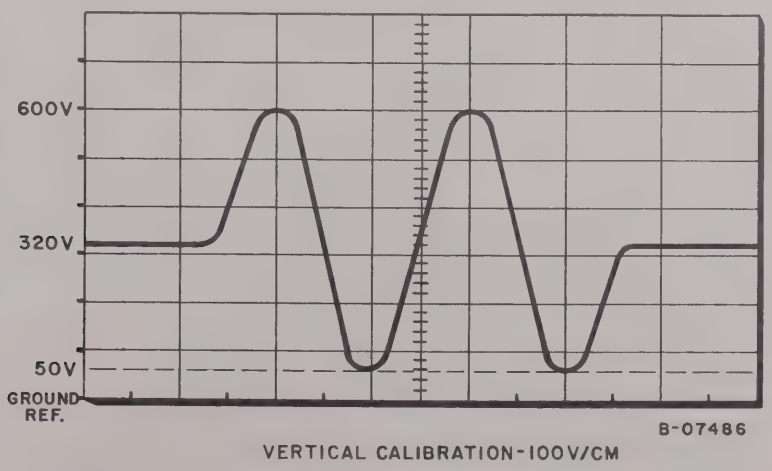


Figure 4-16 MODULATED B+ AS SEEN ON SCOPE GRATICULE (See Paragraph 4.7.8)

4.8 OMNI CIRCUITS

(See Figure 6-1).

4.8.1 Reference Channel Alignment

To check the Omni Reference Channel Alignment proceed as follows:

a. Connect the test equipment to the receiver as described in paragraph 4.5.3.
b. Connect AC VTVM to pin 9 V-10B or test point located on PC Board, refer to figure 6-1, Test point N.
c. Tune T-202 primary and secondary for maximum reading on AC VTVM. (Tune to peaks away from siderail). AC VTVM reading shall be approximately 4.0 volts. NOTE: Improper T-202 tuning indicated by a FROM flag indication.

4.8.2 Variable Phase Alignment

a. Set the Mark 8 course selector dial and the OMNI signal generator to 270°. Set the LEFT-RIGHT indicator to 0 with the OMNI zero set control (R-214).
b. Set the Mark 8 course selector and the OMNI signal generator to 90° and note reading. If an error exists, compensate across R-208 or R-210 for 180° phase shift between 90° and 270°. Then with the signal generator and course selector at 270°, recenter the L-R meter.
c. Set the Mark 8 course selector and the OMNI signal generator to 0° and check for error. Now reset course selector and OMNI generator to 180° and check for error. If necessary, compensate across R-207 or R-209 for 180° phase shift between 0° and 180°. If absolute error is greater than 0.5° compensate C-206 for 90° quadrature between 0° -180° and 90° -270°. See Table 4.1.

4.8.3 Rectifier Balance

a. Set the course selector dial and the OMNI signal generator to 270°. Center the LEFT-RIGHT indicator with the OMNI zero set control R-214. Then set the OMNI signal generator to 90° and note any error present. This error represents reciprocal error. Before compensating this error, the error at 90° should be checked. This is necessary because the reciprocal error at 90° may not be of the same magnitude as that seen at 270°.
b. With the OMNI signal generator set at 90°, adjust the course selector dial to center the L-R needle at 90°. Now reset the generator to 270° and note the reciprocal error, which should not exceed ±2°.
c. If the error is greater than ±2° compensate across R-247 or R-248 for minimum reciprocal error at both the 90° and 270° course selector settings.

4.8.4 VOR Course Width

With a 500 μv OMNI signal applied to the receiver the VOR course width should be 9° to 13° either side of the centered needle (center-to-edge of color). Using a resistance decade box across "L" and "2" on the circuit side of the OMNI printed circuit board select a resistor value to obtain the desired course width (See Figure 6-1). The value of this resistor should NOT be less than 27K.

4.8.5 Localizer Centering Adjustment

a. Set the receiver to a proper Localizer channel and properly set up the OMNI Signal Generator for a Localizer Signal.
b. The only compensation available for centering the Left-Right Indicator is the adjustment marked "LOC." Turn this adjustment (R-226) to center the needle.

Table 4.1 OMNI COMPENSATION (TYPICAL)
(See Paragraph 4.8.2)

COMPENSATION	Compensation Points	COURSE SELECTOR DIAL SETTING	EFFECT ON COURSE SEL. DIAL SETTING
68K OHMS across R-210	A to B_2	0°	1.7° NEGATIVE
68K OHMS across R-210		180°	NONE
68K OHMS across R-210		270°	2.2° NEGATIVE
68K OHMS across R-210		90°	0.7° POSITIVE
68K OHMS across R-209	B_2 to GND	0°	4.0° POSITIVE
68K OHMS across R-209		180°	4.0° NEGATIVE
68K OHMS across R-209		270°	0.2° POSITIVE
68K OHMS across R-209		90°	NONE
68K OHMS across R-208	C to B_1	0°	1.2° POSITIVE
68K OHMS across R-208		180°	0.3° NEGATIVE
68K OHMS across R-208		270°	2.0° POSITIVE
68K OHMS across R-208		90°	1.0° NEGATIVE
68K OHMS across R-207	B_1 to GND	0°	4.0° NEGATIVE
68K OHMS across R-207		180°	4.0° POSITIVE
68K OHMS across R-207		270°	0.5° NEGATIVE
68K OHMS across R-207		90°	0.5° POSITIVE
0.03μF across C-206	B_2 to E	0°	NONE
0.03μF across C-206		180°	NONE
0.03μF across C-206		270°	0.6° POSITIVE
0.03μF across C-206		90°	0.6° POSITIVE

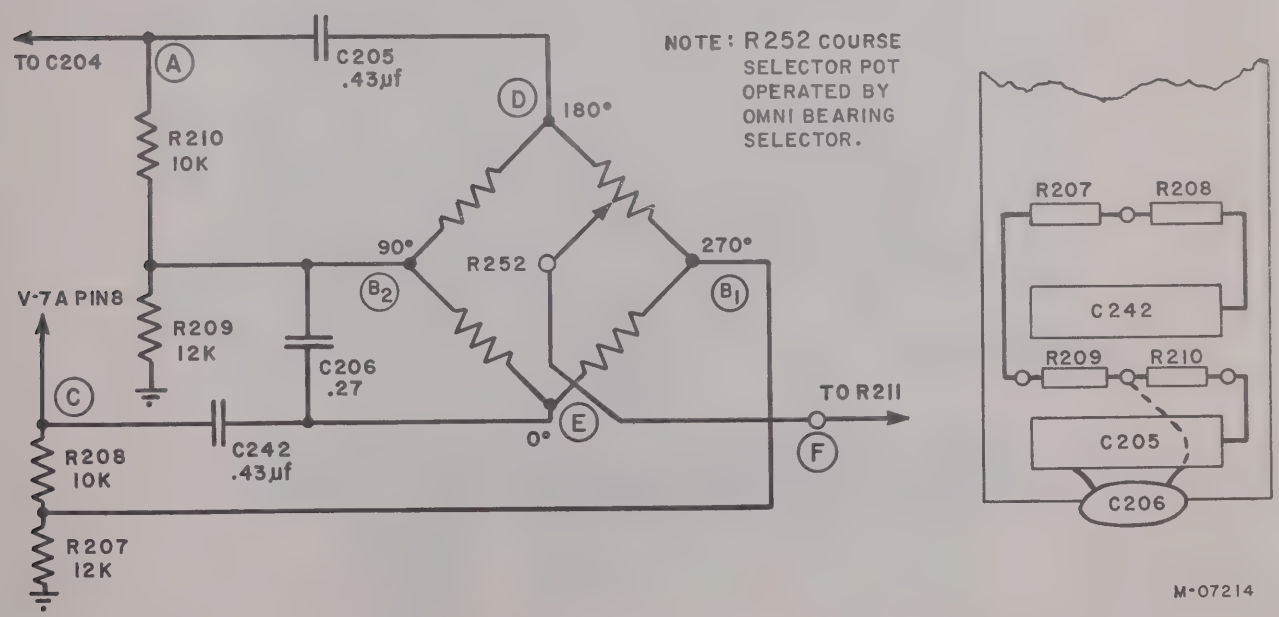


Figure 4-17 OMNI COMPENSATION SCHEMATIC

4.9 PRINTED CIRCUIT METHODS

Printer circuits are very reliable and serviceable when they are properly designed, installed, and maintained. However, they may be easily damaged by improper maintenance procedures. The following methods, if carefully observed, will insure satisfactory repairs.

4.9.1 Tools Required

a. Soldering Iron, small, 40 watts or less.
b. Small Long Nose Pliers.
c. Small Angle Cutters.
d. Small Stiff Bristle Brush, or "solder sipper."
e. Sharp pointed instrument (scriber).

CAUTION

NEVER place the soldering iron directly on the printed circuit if it can be avoided. EXCESSIVE HEAT will raise the circuit from the board.

4.9.2 Replacement of Small Components

a. Cut the leads and remove the component from the board.
b. Using the small soldering iron and long nose pliers, lift the remaining ends of the component from the board.
c. With the tip of the iron open the holes in the board by drawing the solder away from the holes.
d. Bend the leads of the replacement component and fit them through the holes (observing polarity, if any.)
e. Cut off any excess lead length.
f. Observe that contact surfaces are clean, then resolder.

4.9.3 Replacement of transistors and Crystals

a. Heat the leads one at a time and remove the solder with a stiff brush or a "solder sipper."
b. Remove the transistor or crystal by pulling and rocking it gently, while touching the leads with the soldering iron if necessary.
c. Clear the holes of solder and insert the replacement, orienting the connection properly.
d. Observe that contact surfaces are clean then resolder.

CAUTION:

Transistors and Crystals may be damaged by overheating. Use the minimum heat that will still permit rapid removal or replacement.

4.9.4 Replacement of Large Components

a. Heat each joint enough to soften the solder and using the stiff brush, or "solder sipper," remove the solder. Do only one joint at a time, or only as large an area as will require a minimum of heat.
b. GENTLY pull the defective part from the board when all joints have been cleared.
c. Clear the holes and insert the replacement component, orienting correctly.
d. Observe that contact surfaces are clean then resolder.

NOTE - The brushing, or "solder sipping" method described under a. may be used to remove any component where it is undesirable or impossible to cut the leads.

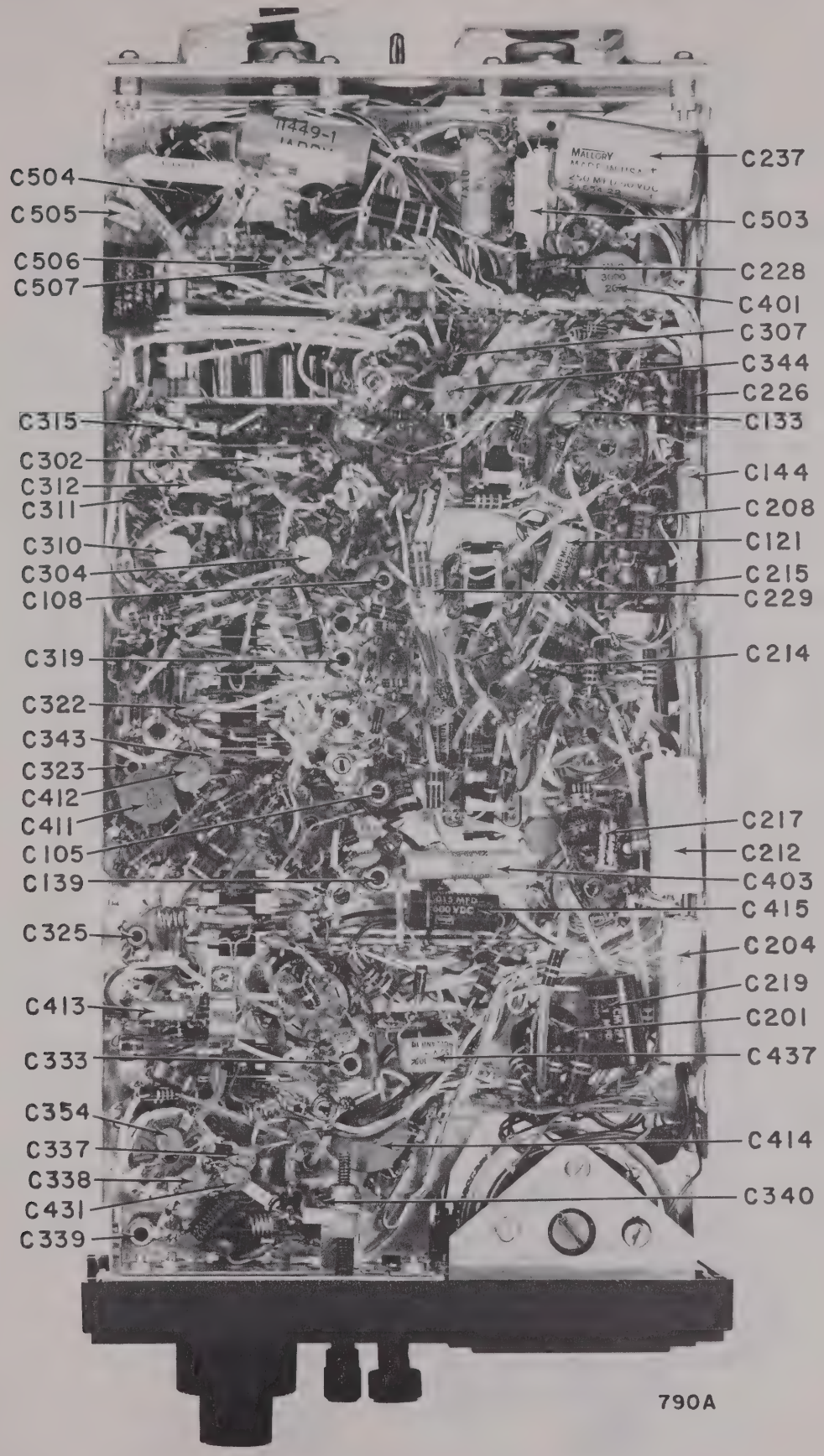


Figure 4-18 MARK 8, Bottom View Sheet 1 of 3)

Figure 4-18 MARK 8, Bottom View (Sheet 2 of 3)

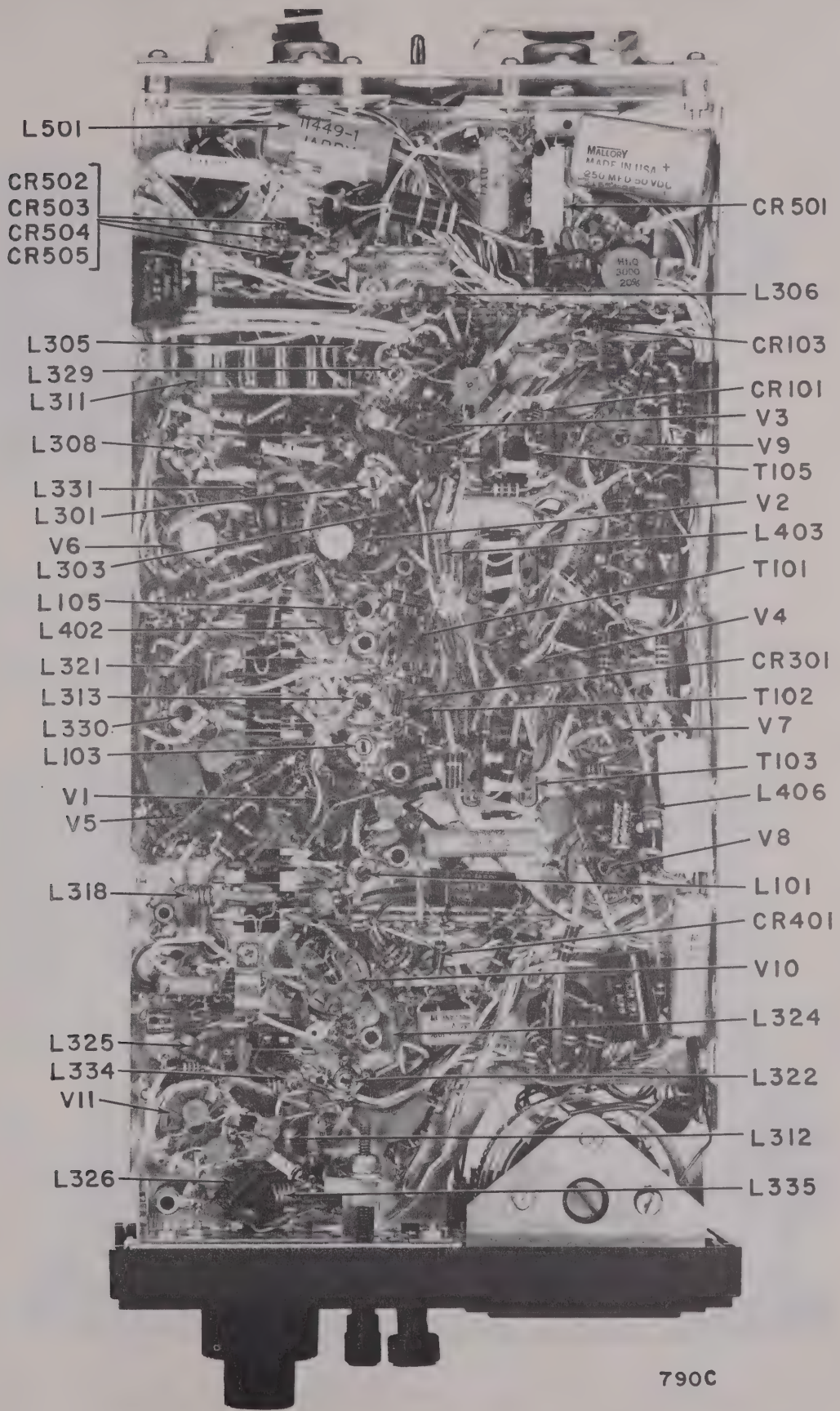


Figure 4-18 MARK 8, Bottom View (Sheet 3 of 3)

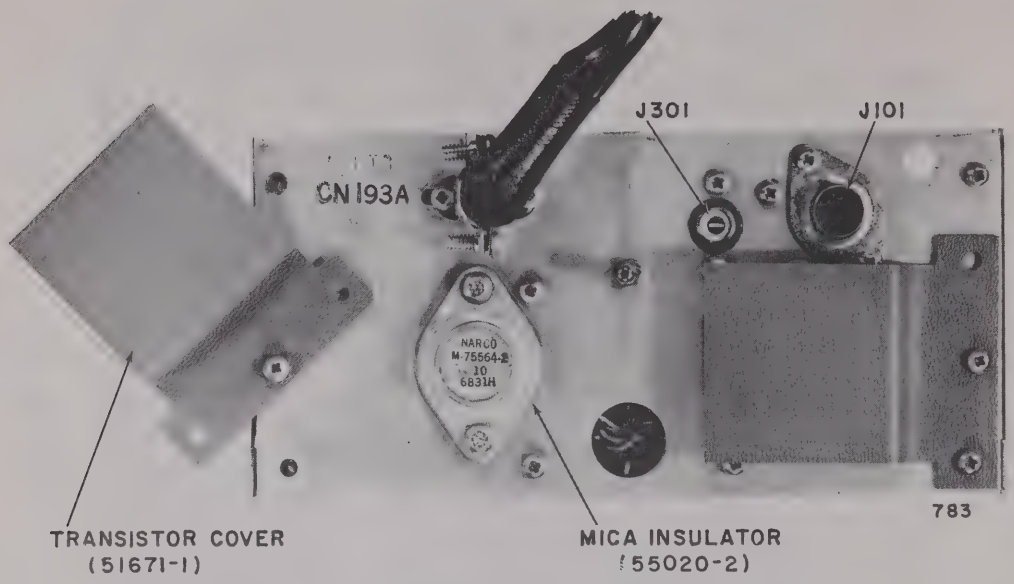


Figure 4-19 MARK 8, Rear Panel (See Paragraph 4.2.4)

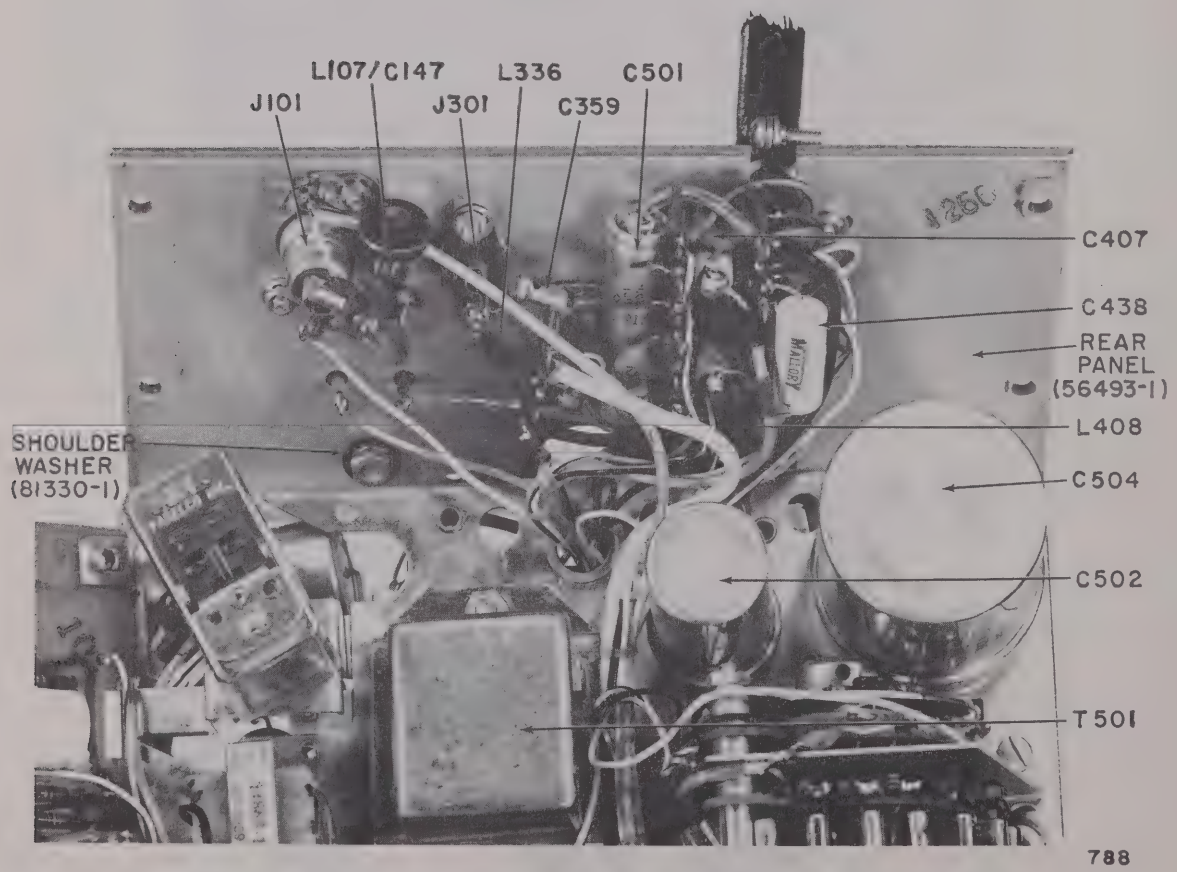
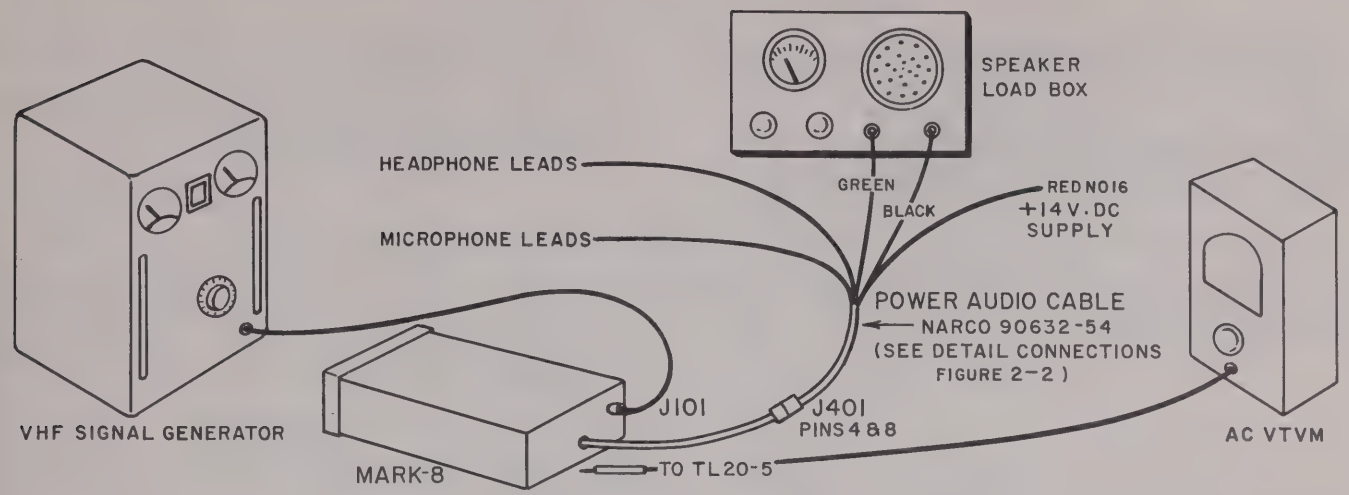
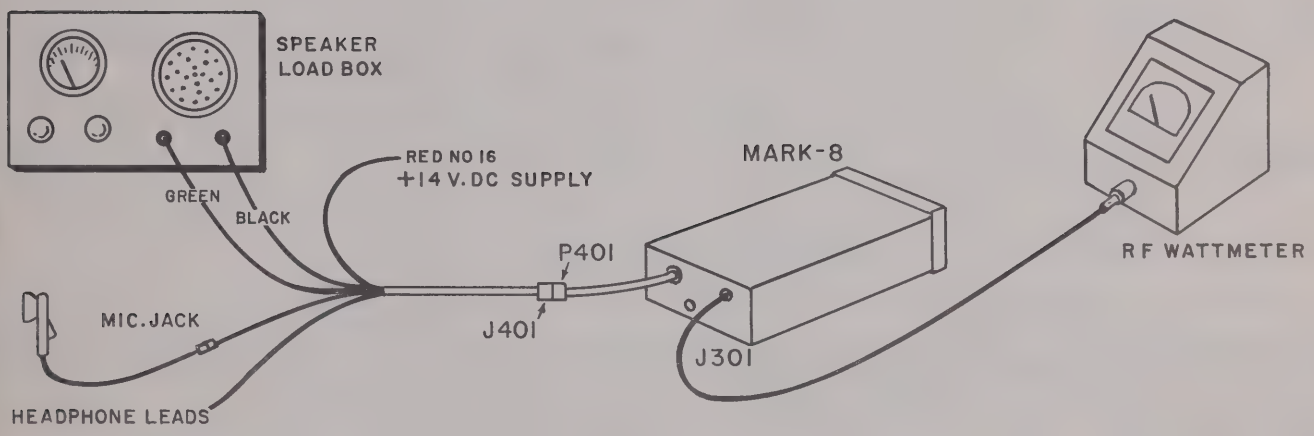


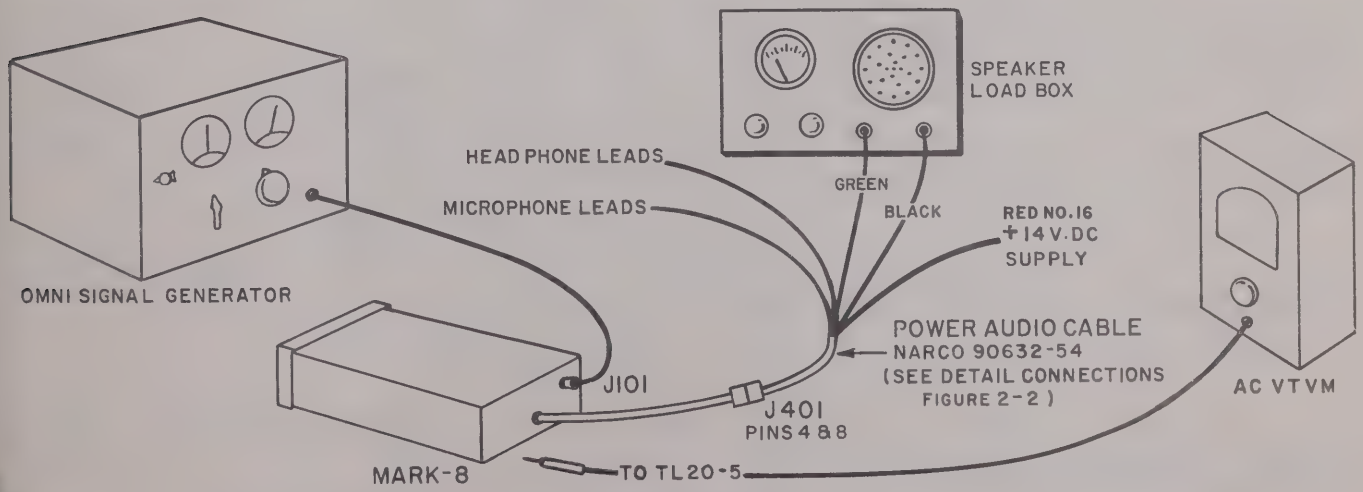
Figure 4-20 MARK 8, Rear Panel Components (See Paragraph 4.2.4)



RECEIVER TEST



TRANSMITTER TEST



OMNI TEST

Figure 4-21 TYPICAL OMNI/RECEIVER/TRANSMITTER TEST SETUP
(See Paragraphs 4.5.1, 4.5.2, and 4.5.3)

TABLE 4.2 TROUBLE SHOOTING

The purpose of these charts is to isolate cause of circuit malfunction and quickly restore proper circuit operation.

Alignment procedures should not be attempted without proper power supply voltages, furthermore do not attempt to align the unit if any portion of the circuit is thought to be malfunctioning in any way.

Test voltages are shown in the charts opposite their applicable schematic found in Section 6.

I RECEIVER

TROUBLE	Suggested Test Areas
Weak on all channels	Check Tuning of RF amp (V-1A) at 118.5 and 126.5. Check tuning and grid volts of HFO (V-2B) and LFO (V-3B). Check overall RF and IF alignment. Audio amplifier operation. (See Chart IV)
Weak or dead on one or more channels	Low activity or dead crystal.
No noise or signal with volume control full clockwise.	Check HFO and LFO operation, overall alignment audio amplifier stage gain. (See Chart IV)
Noise, but no signal	Check 1st mixer (V-2A) and RF amp (V-1A). Connections at receiver antenna connector J-101, shorted FM trap L107/C147. Continuity of coax cable from J-101 to L-101.
Distortion on strong signals	Check AGC operation AGC voltage. AGC voltage 0 v at 1.5-2.0 μv output rising to approximately -1.5 vdc at 5 μv and steadly going negative.

II NAV CONVERTER

TROUBLE	Suggested Test Area
Both Left-Right and TO-FROM indicators centered and inactive on OMNI and Localizer frequencies. Receiver audio OK.	Trace OMNI signal with scope or AC VTVM from set output point thru OMNI circuits. Check switch contacts of S201 and S202. Check V-7A, V-8A, V-4B, V-3A, and V-9B for signal output.
Both Indicators function on Localizer, but not on OMNI.	V-7A defective. Check contacts on S202A/B. R252 (OBS pot) defective
Left-Right indicator defective, TO-FROM OK.	Shorted C239 No Signal Present from C237 to point L-R. Defective CR203 or CR205
TO-FROM indicator defective. Left - Right OK	Shorted C240 or C241 Defective CR204 or CR206 Open winding T203
Both Meters indicating one direction only.	**LEFT-RIGHT** Broken R247 or R248 Shorted CR203 or CR205 TO-FROM **TO-FROM** Broken R249 or R250 Shorted CR204 or CR206

III TRANSMITTER

TROUBLE	Suggested Test Area
No output on any channel	Check HFO (V-6B) and LFO (V-3B) operation. V-1B, V-5B, V-10 or V-11 defective. Q301, or Q302 defective. Output filter L336, C357, C359
Low output on all COM channels (118.0-126.9).	Defective Q301 or Q302. Check alignment.
Little or no output on NAV channels (108.0-117.9).	Tuning of L331 osc. coil. Alignment of coils L332, L333, L334, and L335. Defective crystal (XT316)
Low Output	Misalignment
Little or No output on one channel	Defective crystal
Low or no modulation. Receiver audio OK.	Check Microphone Circuit. Shorted C407, C414, C415. Defective R407, R408, CR401 Audio Amplifier operation (Chart IV)

IV AUDIO AMPLIFIER

TROUBLE	Suggested Test Area
No output and no modulation	Audio fuse blown, defective Q401, Q402, V-6A, or V5A. Shorted C409, C412, R409
Low audio gain	Check V6A, V5A. Check Base bias of Q401/Q402.
Operation on receive only	Check relay operation. Defective modulation winding of T402.
Operation on transmit only	Check relay operation. Defective speaker winding T402.

V POWER SUPPLY

TROUBLE	Suggested Test Area
No high voltage	Defective Q501 or Q502 Short in B+ wiring Defective CR502, CR503, CR504, or CR505 Defective R504, R505, or C504
Low voltage	One power transistor defective, Q501 or Q502 Defective tube or component causing excess B+ current drain. Defective diode CR502, CR503, CR504, or CR505.

5.1 INTRODUCTION

This Replacement Parts List supports the Mark 8 NAV/COM. Standard commercial parts are listed with a NARCO part number and a complete description. Special parts, applicable only to the Mark 8, are listed with a NARCO part number and a basic description, these parts must be ordered from NARCO.

When ordering any replacement part, specify the NARCO part number and the description.

MARK 8 MECHANICAL PARTS

Symbol	Part Number	Description
	04383-1	LABEL, TUBE LOCATION
	04359-1	LABEL, PATENT NOTICE
	04069-1	LABEL, FCC PART 15 (REC. RAD.)
	04342-1	LABEL, LOGO
	51675-1	TRIM PANEL
	51696-1	FIDUCIAL
	51681-1	BRACKET, IDENT. VOL.
	51682-2	EXTENSION SHAFT, IDENT. VOL.
	51683-1	HEATSINK, AUDIO
	51698-1	BRACKET, OBS DRIVE
	51688-1	PULLEY & SHAFT
	51687-1	LENS, OBS
	88183-1	DRUM, OBS
	51691-1	GUIDE OBS DRIVE (NYLON)
	54960-3	BELT, GEAR
	51694-1	RETAINER, BELT
	51686-1	LENS, CHANNEL SELECT
	51697-1	SHIELD, LIGHT
	51695-1	BRACKET LATCH
	51699-1	GUIDE
	88178-1	KNOB, MHz
	88179-1	DIAL, MHz
	88180-1	HUB, MHz
	88181-1	KNOB, KHz
	88182-1	DIAL, KHz
	88193-2	KNOB (GENERAL)
	04380-3	KNOB INSERT, VOL.
	04380-4	KNOB INSERT, OBS
	51670-1	BRACKET, TRANSFORMER
	54642-1	BRACKET, FILTER
	56493-1	PANEL, REAR
	51635-1	PANEL, LEFT SIDE
	51637-2	PANEL, RIGHT SIDE
	51639-1	RETAINER, SWITCH
	51634-1	BRACKET, DETENT SUPPORT
	51647-1	SHIELD, TUBE SOCKET
	51631-1	SHIELD
	51636-1	SHIELD, CRYSTAL ASSEMBLY
	51632-1	SPRING, RETAINER
	51653-1	SHIELD, COIL
	51640-1	SHAFT, KHz
	56429-2	SHAFT, MHz
	54514-1	SPRING, GROUNDING
	51671-1	SHIELD, TRANSISTOR

MARK 8 MECHANICAL PARTS

Symbol	Part Number	Description
	51644-101	DETENT ROTOR ASSEMBLY, KHz
	61401-1	DETENT ROLLER, KHz
	61402-1	DETENT SPRING, KHz
	61463-1	SHAFT & DETENT ASS'Y 20 POS - MHz
	61405-101	FRONT PLATE (DETENT)
	51649-102	PRINTED BOARD OMNI ASSEMBLY
	51645-1	PRINTED BOARD CRYSTAL MOUNTING
	51664-2	ADAPTOR, AIR
	51648-101	CASE ASSEMBLY
	52768-1	LATCH
	51647-2	SHIELD, TUBE SOCKET
	81307-3	WASHER, FLAT SPECIAL .265
	81330-1	WASHER, SHOULDER
	81335-8	WASHER, SHOULDER
	81213-74	SPACER, METER
	81213-75	SPACER, LAMPHOLDER
	81214-10	SPACER
	81432-4	TIE LUG STRIP, 2 LUG
	81432-5	TIE LUG STRIP, 2 LUG
	81434-4	TIE LUG STRIP, 3 LUG
	81434-3	TIE LUG STRIP, 3 LUG
	81434-12	TIE LUG STRIP, 3 LUG
	81433-6	TIE LUG STRIP, 4 LUG
	81433-2	TIE LUG STRIP, 4 LUG
	81433-8	TIE LUG STRIP, 4 LUB
	81434-6	TIE LUG STRIP, 5 LUG
	81443-1	TIE LUG STRIP, 5 LUG
	81443-2	TIE LUG STRIP, 5 LUG
	81442-1	TIE LUG STRIP, 6 LUG
	81442-9	TIE LUG STRIP, 6 LUG
	81431-4	TIE LUG STRIP, 7 LUG
	81431-6	TIE LUG STRIP, 7 LUG
	81431-9	TIE LUG STRIP, 7 LUG
	81436-5	TIE LUG STRIP, 9 LUG
	81436-7	TIE LUG STRIP, 9 LUG
	81438-4	TIE LUG STRIP, 12 LUG
	81785-8	LUG, SOLDER
	81656-11	BUTTON, PLUB
	81677-11	HEX. POST, SPECIAL
	81688-3	CLIP, CAPACITOR
	81192-7	TRUARC RETAINING RING
	82011-1	CLAMP, CABLE
	81511-1	FASTENER, TINNERMAN
	81297-5	RETAINING RING
	55020-2	INSULATOR, TRANSISTOR
	84049-8	BEARING, NYLON
	81358-2	GROMMET, STRIP
	41278-3	LAMPHOLDER
	41278-4	LAMPHOLDER
	42060-4	TUBE SOCKET, 9 PIN RECESSED
	42051-3	TUBE SHIELD, BLACK
	42034-3	TUBE SOCKET, 9 PIN
	42034-2	TUBE SOCKET, 9 PIN
	41181-2	CONNECTOR, 11 PIN P-401
	41182-2	CAP, CONNECTOR
	41235-1	JACK, BANANA
	41236-2	PLUG, BANANA

MARK 8 ELECTRICAL PARTS

Symbol	Part Number	Description
C-101	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-102	21291-24	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-103	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-104	21291-25	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-105	22019-1	CAPACITOR, CERAMIC TRIMMER, 0.5 - 4.5 pf
C-106	24509-338	CAPACITOR, CERAMIC TUB. .33 pf ±5%, 500V
C-107	24516-829	CAPACITOR, CERAMIC DISC, 8.2 pf ±.5 pf, 500V
C-108	22043-1	CAPACITOR, TRIMMER .7-3 pf 350V
C-109	21291-14	CAPACITOR, CERAMIC DISC, 100 pf ±10%, 500V
C-110	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-111	21291-18	CAPACITOR, CERAMIC DISC, 330 pf ±10%, 500V
C-112	21291-8	CAPACITOR, CERAMIC DISC, .003 mf ±20%, 500V
C-113	23085-63	CAPACITOR, MYLAR .01 mf ±10%, 100V
C-115	24509-109	CAPACITOR, CERAMIC TUB. 1.0 pf ±5%, 500V
C-116	24515-1	CAPACITOR, CERAMIC DISC, .1 mf +80% -20%, 10V
C-117	21206-120	CAPACITOR, CERAMIC TUB. 12.0 pf ±10%, 500V, N470
C-118	21206-120	CAPACITOR, CERAMIC TUB. 12.0 pf ±10%, 500V, N470
C-119	21291-6	CAPACITOR, CERAMIC DISC, .01 mf, 500V, GMV
C-120	23085-63	CAPACITOR, MYLAR, .01 mf ±10%, 100V
C-121	23089-79	CAPACITOR, MYLAR, .22 pf ±10%, 80V
C-122	21291-6	CAPACITOR, CERAMIC DISC, .01 mf, 500V GMV
C-123	24515-1	CAPACITOR, CERAMIC DISC, .1 mf, +80% -20%, 10V
C-125	21206-120	CAPACITOR, CERAMIC TUB. 12.0 pf ±10%, 500V N470
C-126	21206-120	CAPACITOR, CERAMIC TUB. 12.0 pf ±10%, 500V N470
C-127	21291-8	CAPACITOR, CERAMIC DISC, .003 mf ±20%, 500V
C-129	23085-63	CAPACITOR, MYLAR, .01 mf ±10%, 100V
C-130	23089-79	CAPACITOR, MYLAR, .22 mf ±10%, 80V
C-131	21206-120	CAPACITOR, CERAMIC TUB. 12.0 pf ±10%, 500V N470
C-132	21291-6	CAPACITOR, CERAMIC DISC, .01 mf, 500V GMV
C-133	24515-1	CAPACITOR, CERAMIC DISC, .1 mf +80% -20%, 10V
C-135	21206-120	CAPACITOR, CERAMIC TUB. 12.0 pf ±10%, 500V N470
C-136	21291-14	CAPACITOR, CERAMIC DISC, 100 pf ±10%, 500V
C-137	21291-14	CAPACITOR, CERAMIC DISC, 100 pf ±10%, 500V
C-138	23085-75	CAPACITOR, MYLAR, .1 mf ±10%, 100V
C-139	22019-1	CAPACITOR, CERAMIC TRIMMER, 0.5 - 4.5 pf
C-140	24516-229	CAPACITOR, CERAMIC DISC, 2.2 pf ±.25 pf, 500V NPO
C-144	23089-171	CAPACITOR, MYLAR, .047 uf ±10%, 200V
C-145	24045-512	CAPACITOR, DIPPED MICA, 5100 pf ±5%, 300V
C-201	21525-28	CAPACITOR, 20/350V 40/200V 20/200V CAN
C-202	23085-155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-203	23085-155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-204	21554-7	CAPACITOR, TUB. ELECTROLYTIC INS., 16 uf/ 150V
C-205	23077-1	CAPACITOR, MYLAR, .43 mf ±1%, 50V
C-206	23091-79	CAPACITOR, MYLAR, .22 mf ±10%, 100V
C-207	23094-179	CAPACITOR, MYLAR, .22 mf ±10%, 200V
C-208	23085-63	CAPACITOR, MYLAR, .01 mf ±10%, 100V
C-209	23094-170	CAPACITOR, MYLAR, .039 mf ±10%, 200V
C-210	23092-125	CAPACITOR, POLY CARBON, 0.1 uf ±5%, 75V
C-211	23092-125	CAPACITOR, POLY CARBON, 0.1 uf ±5%, 75V
C-212	21558-6	CAPACITOR, TUB. ELECTRO. 300/3V
C-213	23085-163	CAPACITOR, MYLAR, .01 mf ±10%, 200V
C-214	23085-62	CAPACITOR, MYLAR, .0082 mf ±10%, 100V
C-215	24045-911	CAPACITOR, DIPPED MICA, 910 pf ±5%, 500V
C-216	21291-11	CAPACITOR, CERAMIC DISC, 200 pf +10%, 500V
C-217	23085-159	CAPACITOR, MYLAR, .0047 mf ±10%, 200V
C-218	23085-155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-219	23085-175	CAPACITOR, MYLAR, .1 mf ±10%, 200V

MARK 8 ELECTRICAL PARTS Continued

Symbol	Part Number	Description
C-220	24045-472	CAPACITOR, DIPPED MICA, 4700 pf ±5%, 300V
C-221	24045-472	CAPACITOR, DIPPED MICA, 4700 pf ±5%, 300V
C-222	23085-464	CAPACITOR, MYLAR, .012 mf ±5%, 200V
C-223	23085-159	CAPACITOR, MYLAR, .0047 mf ±10%, 200V
C-224	21291-11	CAPACITOR, CERAMIC DISC, 200 pf ±10%, 500V
C-225	21291-11	CAPACITOR, CERAMIC DISC, 200 pf ±10%, 500V
C-226	23085-63	CAPACITOR, MYLAR, .01 mf ±10%, 100V
C-227	21291-11	CAPACITOR, CERAMIC DISC, 200 pf ±10%, 500V
C-228	24045-911	CAPACITOR, DIPPED MICA, 910 pf ±5%, 500V
C-229	23089-171	CAPACITOR, MYLAR, .047 mf ±10%, 200V
C-230	23085-171	CAPACITOR, MYLAR, .047 mf ±10%, 200V
C-231	23092-63	CAPACITOR, POLY CARBON, .01 uf ±10%, 75V
C-232	23092-63	CAPACITOR, POLY CARBON, .01 uf ±10%, 75V
C-233	23094-171	CAPACITOR, MYLAR, .047 mf ±10%, 200V
C-234	23094-171	CAPACITOR, MYLAR, .047 mf ±10%, 200V
C-235	23094-169	CAPACITOR, MYLAR, .033 mf ±10%, 200V
C-236	23094-175	CAPACITOR, MYLAR, .1 mf ±10%, 200V
C-237	21554-22	CAPACITOR, ELECTRO. 250 uf 50V
C-239	21558-2	CAPACITOR, ELECTRO., 1000 uf, 0.1V NP
C-240	23091-71	CAPACITOR, MYLAR, .047 mf ±10%, 100V
C-241	21547-1	CAPACITOR, ELECTRO., 500 uf 0.1 V NP
C-242	23077-1	CAPACITOR, MYLAR, .43 mf ±1%, 50V
C-243	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-244	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1000V
C-245	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1000V
C-246	21291-11	CAPACITOR, CERAMIC DISC, 200 pf ±10%, 500V
C-247	21291-25	CAPACITOR, CERAMIC DISC, 430 pf ±20%, 500V
C-301	24049-121	CAPACITOR, DIPPED MICA, 120 pf ±5%, 500V
C-302	21211-560	CAPACITOR, CERAMIC TUB. 56 pf ±10%, 500V NPO
C-303	21291-25	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-304	22041-3	CAPACITOR, TIMMER, 2 - 8 pf, 500V NPO
C-305	21201-220	CAPACITOR, CERAMIC TUB. 22pf ±10%, 500V NPO
C-306	21291-21	CAPACITOR, CERAMIC DISC, . 001 pf ±20%, 1000V
C-307	24049-331	CAPACITOR, DIPPED MICA, 330 pf ±5%, 500V
C-309	24049-111	CAPACITOR, DIPPED MICA, 110 pf ±5%, 500V
C-310	22041-3	CAPACITOR, TRIMMER, 2 - 8 pf, 500V NPO
C-311	24049-101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 500V
C-312	21211-470	CAPACITOR, CERAMIC TUB. 47 pf ±10%, 500V NPO
C-313	21291-21	CAPACITOR, CERAMIC DISC, .001 pf ±20%, 1000V
C-314	21291-25	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-315	21201-330	CAPACITOR, CERAMIC TUB. 33 pf ±10%, 500V NPO
C-316	24516-100	CAPACITOR, CERAMIC DISC, 10 pf ±10%, 500V
C-317	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-319	22019-1	CAPACITOR, TRIMMER, 0.5 - 4.5 pf, 500V
C-320	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-321	24534-1	CAPACITOR, CERAMIC DISC, 33 pf ±5%, NPO, 500V
C-322	24516-229	CAPACITOR, CERAMIC DISC, 2.2 pf ±.5 pf, 500V, NPO
C-323	22043-1	CAPACITOR, TRIMMER, .7 - 3 pf, 350V
C-324	21291-24	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-325	22043-1	CAPACITOR, TRIMMER, .7 - 3 pf, 350V
C-326	21291-18	CAPACITOR, CERAMIC DISC, 330 pf ±10%, 500V
C-327	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-328	24516-150	CAPACITOR, CERAMIC DISC, 15 pf ±10%, 500V NPO
C-329	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-330	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-331	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-332	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-333	22019-1	CAPACITOR, CERAMIC TRIMMER, 0.5 - 4.5 pf, 500V
C-334	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-335	24516-150	CAPACITOR, CERAMIC DISC, 15 pf ±10%, 500 V NPO
C-336	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-337	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-338	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-339	22019-1	CAPACITOR, CERAMIC TRIMMER, 0.5 - 4.5 pf, 500V

MARK 8 ELECTRICAL PARTS Continued

Symbol	Part Number	Description
C-340	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-341	21211-560	CAPACITOR, CERAMIC TUB. 56 pf ±10%, 500V NPO
C-342	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-343	24516-339	CAPACITOR, CERAMIC DISC, 3.3 pf ±.5 pf, 500V NPO
C-344	21291-6	CAPACITOR, CERAMIC DISC, .01 mf 500V, GMV
C-345	21291-18	CAPACITOR, CERAMIC DISC, 300 pf ±10%, 500V
C-346	21291-18	CAPACITOR, CERAMIC DISC, 300 pf ±10%, 500V
C-347	24516-180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V NPO
C-348	21206-829	CAPACITOR, CERAMIC TUB. 8.2 pf ±.5 pf, 500V N470
C-349	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-350	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-351	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-352	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-353	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-354	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-355	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-356	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-357	21201-330	CAPACITOR, CERAMIC TUB. 33 pf ±10%, 500V NPO
C-358	21291-25	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-359	21201-330	CAPACITOR, CERAMIC DISC, 33 pf ±10%, 500V NPO
C-360	21291-21	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-401	21291-8	CAPACITOR, CERAMIC DISC, .003 uf ±20%, 500V
C-402	21291-14	CAPACITOR, CERAMIC DISC, 100 pf ±10%, 500V
C-403	23089-83	CAPACITOR, MYLAR, .47 mf ±10%, 80V
C-404	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-405	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-406	23085-75	CAPACITOR, MYLAR, 0.1 mf ±10%, 200V
C-407	21291-5	CAPACITOR, CERAMIC DISC, .01 mf +80% -30%, 50V
C-408	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-409	21291-8	CAPACITOR, CERAMIC DISC, .003 uf ±20%, 500V
C-410	21291-14	CAPACITOR, CERAMIC DISC, 100 pf ±10%, 500V
C-411	24515-2	CAPACITOR, CERAMIC DISC, 0.2 uf +80% -20%, 10V
C-412	21291-6	CAPACITOR, CERAMIC DISC, .01 uf 500V GMV
C-413	23094-179	CAPACITOR, MYLAR, .22 uf ±10%, 200V
C-414	24515-11	CAPACITOR, CERAMIC DISC, 0.2 uf +80% -20%, 16V
C-415	23085-315	CAPACITOR, MYLAR, .015 uf ±20%, 600V
C-416	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-417	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-418	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-419	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-420	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-421	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-422	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-423	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-424	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-425	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-426	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-427	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-428	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-429	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-430	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-431	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-432	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-433	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-434	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-435	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-436	21291-21	CAPACITOR, CERAMIC DISC, .001 uf ±20%, 1KV
C-437	23094-179	CAPACITOR, MYLAR, .22 uf ±10%, 200V
C-438	21558-4	CAPACITOR, ELECTROLYTIC, 30 uf, 15V
C-501	21554-4	CAPACITOR, ELECTROZYTIC, 100 uf, 30V
C-502	21525-17	CAPACITOR, ELECTROLYTIC, 400 uf, 15V
C-503	21558-4	CAPACITOR, ELECTROLYTIC, 30 uf, 15V
C-504	21556-2	CAPACITOR, ELECTROLYTIC, 60 & 20/200, 15/350, 30/400
C-505	23094-171	CAPACITOR, MYLAR, .047 MF ±10%, 200V
C-506	21291-25	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-507	21291-25	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V

MARK 8 ELECTRICAL PARTS Continued

Symbol	Part Number	Description
CR-101	75023-1	DIODE, SILICON
CR-102	75019-2	DIODE, SILICON
CR-103	75013-4	DIODE, SILICON
CR-201		
CR-202	75023-1	DIODE, SILICON
CR-203	75023-1	DIODE, SILICON
CR-204	75023-1	DIODE, DILICON
CR-205	75023-1	DIODE, SILICON
CR-206	75023-1	DIODE, SILICON
CR-301	75013-6	DIODE, SILICON
CR-302	75013-6	DIODE, SILICON
CR-401	75204-45	DIODE, SILICON, 500V PI V
CR-501	75204-45	DIODE, SILICON, 500V PIV 750 MA
CR-502	75204-45	DIODE, SILICON, 500V PIV 750 MA
CR-503	75204-45	DIODE, SILICON, 500V PIV 750 MA
CR-504	75204-45	DIODE, SILICON, 500V PIV 750 MA
CR-505	75204-45	DIODE, SILICON, 500V PIV 750 MA
F-401	66509-1	FUSE, PIGTAIL FASTACTING, 2 AMPS
I-401	12000-15	LAMP #336, 14V CLEAR
I-402	12000-15	LAMP #336, 14V CLEAR
I-403	12000-15	LAMP #336, 14V CLEAR
I-404	12000-15	LAMP #336, 14V CLEAR
J-101	41143-3	CONNECTOR, CHASSIS FEMALE
J-301	41110-2	CONNECTOR, CHASSIS FEMALE
K-401	65141-1	RELAY
L-101	11483-1	COIL, ANT.
L-102	61436-101	COIL, ANT. VAR. IND.
L-103	11484-2	COIL, RF PLATE
L-104	61436-101	RF PLATE VAR. Ind.
L-105	11504-2	COIL, HFO DBLR.
L-106	61436-101	MIXER, GRID VAR. IND.
L-107	11198-1	COIL, TRAP.
L-301	11484-1	COIL, REC. HFO
L-302	61450-101	REC. HFO VAR. IND.
L-303	11138-19	CHOKE, RF 15 uh, ±10%
L-304	11138-3	CHOKE, RF 0.22 uh, ±20%
L-305	11138-7	CHOKE, RF 1.0 uh, ±10%
L-306	11138-9	CHOKE, RF 2.2 uh, ±10%
L-307	61469-101	LFO VAR. IND. & XTAL SW.
L-308	11471-1	COIL, TRANS. HFO
L-309	61443-102	TRANS. HFO VAR. IND.
L-310	11138-9	CHOKE, RF 2.2 uh, ±10%
L-311	11138-3	CHOKE, RF 0.22 uh, ±20%
L-312	11138-5	CHOKE, RF 0.47 uh, ±20%
L-313	11504-1	COIL, TRANS. HFO DLBR.
L-314	61443-102	TRANS. HFO VAR. IND.
L-315	11138-3	CHOKE, RF 0.22 uh, ±20%

MARK 8 ELECTRICAL PARTS Continued

Symbol	Part Number	Description
L-316		
L-317	61443-102	TRANS. MIXER VAR. IND.
L-318	11740-1	COIL, 1st BUFFER (6 Turns)
L-319	61443-102	VAR. IND., 1st BUFFER
L-320	11138-5	CHOKE, RF 0.47 uh, ±20%
L-321	11138-5	CHOKE, RF 0.47 uh, ±20%
L-322	11473-1	COIL, 2nd BUFFER
L-323	61490-101	VAR. IND., 2nd BUFFER
L-324	11138-5	CHOKE, RF 0.47 uh, ±20%
L-325	11138-9	CHOKE, RF 2.2 uh, ±10%
L-326	11477-2	TANK, P. A. PLATE
L-327	61490-101	VAR. IND., P. A. Plate
L-328	11138-5	CHOKE, RF .47 uh, ±20%
L-329	11476-1	COIL, LFO
L-330	11475-1	COIL, TRANS. MIXER
L-331	11669-3	COIL, 122.1 MHz HFO
L-332	11692-1	COIL, DOUBLER 122.1 MHz
L-333	11692-1	COIL, 1st BUFFER 122.1 MHz
L-334	11678-1	COIL, 2nd BUFFER 122.1 MHz
L-335	11668-1	COIL, FINAL 122-1 MHz
L-336	11135-9	CHOKE, RF .09 uh
L-401	11446-3	INDUCTOR, ADJUSTABLE 5h CT
L-402	11138-5	CHOKE, RF INSULATED, 0.47 uh ±20%
L-403	11138-5	CHOKE, RF INSULATED, 0.47 uh ±20%
L-404	11138-5	CHOKE, RF INSULATED, 0.47 uh ±20%
L-405	11138-5	CHOKE, RF INSULATED, 0.47 uh ±20%
L-406	11138-5	CHOKE, RF INSULATED, 0.47 uh ±20%
L-407	11138-5	CHOKE, RF INSULATED, 0.47 uh ±20%
L-408	11138-25	CHOKE, RF INSULATED, 86 uh ±5%
L-501	11449-1	CHOKE, HASH, 50 uh
M201-A	76065-2	INDICATOR, DUAL PURPOSE
M201-B		INDICATOR, DUAL PURPOSE (PART OF M-201-A)
Q-301	75568-2	TRANSISTOR, SILICON NPN 2N3563
Q-302	75568-2	TRANSISTOR, SILICON NPN 2N3563
Q-401	75576-1	TRANSISTOR, AUDIO
Q-402	75576-1	TRANSISTOR, AUDIO
Q-501	75564-2	TRANSISTOR, POWER SILICON NPN
Q-502	75564-2	TRANSISTOR, POWER SILICON NPN
R-101	31192-681	RESISTOR, CARBON, 680 ±10%, ¼W
R-102	31141-102	RESISTOR, CARBON, 1K ±10%, ½W
R-103	31192-104	RESISTOR, CARBON, 100K ±10%, ¼W
R-104	31141-151	RESISTOR, CARBON, 150 ±10%, ¼W
R-105	31192-104	RESISTOR, CARBON, 100K ±10%, ¼W
R-106	31192-102	RESISTOR, CARBON, 1K ±10%, ¼W
R-107	31141-102	RESISTOR, CARBON, 1K ±10%, ½W
R-108	31192-273	RESISTOR, CARBON, 27K ±10%, ¼W
R-109	31141-151	RESISTOR, CARBON, 150 ±10%, ½W
R-110	31192-103	RESISTOR, CARBON, 10K ±10%, ¼W
R-111	31192-471	RESISTOR, CARBON, 470 ±10%, ¼W
R-112	31192-102	RESISTOR, CARBON, 1K ±10%, ¼W
R-113	31192-151	RESISTOR, CARBON, 150 ±10%, ¼W
R-114	31141-151	RESISTOR, CARBON, 150 ±10%, ½W
R-115	31192-221	RESISTOR, CARBON, 220 ±10%, ¼W

MARK 8 ELECTRICAL PARTS Continued

Symbol	Part Number	Description
R-116	31192-474	RESISTOR, CARBON, 470K ±10%, ¼W
R-117	31141-685	RESISTOR, CARBON, 6.8 MEG ±10%, ½W
R-118	31192-103	RESISTOR, CARBON, 10K ±10%, ¼W
R-119	31141-151	RESISTOR, CARBON, 150 ±10%, ½W
R-120	31141-151	RESISTOR, CARBON, 150 ±10%, ½W
R-121	31192-221	RESISTOR, CARBON, 220 ±10%, ¼W
R-122	31192-474	RESISTOR, CARBON, 470K ±10%, ¼W
R-123	31192-273	RESISTOR, CARBON, 27K ±10%, ¼W
R-124	31192-103	RESISTOR, CARBON, 10K ±10%, ¼W
R-125	31192-105	RESISTOR, CARBON, 1.0 MEG ±10%, ¼W
R-126	31192-124	RESISTOR, CARBON, 120K ±10%, ¼W
R-127	31192-105	RESISTOR, CARBON, 1.0 MEG ±10%, ¼W
R-128	31195-473	RESISTOR, CARBON, 47K ±5%, ¼W
R-129	32040-6	RESISTOR, POT, 1.0 MEG W/ON-OFF
R-201	31141-223	RESISTOR, CARBON, 22K ±10%, ½W
R-202	31141-104	RESISTOR, CARBON, 100K ±10%, ½W
R-203	31192-474	RESISTOR, CARBON, 470K ±10%, ¼W
R-204	31192-335	RESISTOR, CARBON, 3.3 MEG ±10%, ¼W
R-205	31192-155	RESISTOR, CARBON, 1.5 MEG ±10%, ¼W
R-206	31192-104	RESISTOR, CARBON, 100K ±10%, ¼W
R-207	31177-123	RESISTOR, MET. FILM, 12K ±1%, ½W
R-208	31177-1002	RESISTOR, MET. FILM, 10K ±1%, ½W
R-209	31177-123	RESISTOR, MET. FILM, 12K ±1%, ½W
R-210	31177-1002	RESISTOR, MET. FILM, 10K ±1%, ½W
R-211	31141-184	RESISTOR, CARBON, 180K ±10%, ½W
R-212	31192-334	RESISTOR, CARBON, 330K ±10%, ¼W
R-213	31199-289	RESISTOR, METAL FILM, 8.25K ±1%, ¼W
R-214	32045-4	RESISTOR, VAR. WIREWOUND, 2.5 K ±20%, 2W
R-215	31192-562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R-216	31141-474	RESISTOR, CARBON, 470K ±10%, ½W
R-217	31141-683	RESISTOR, CARBON, 68K ±10%, ½W
R-218	31141-223	RESISTOR, CARBON, 22K ±10%, ½W
R-219	31195-564	RESISTOR, CARBON, 560K ±5%, ¼W
R-220	31192-155	RESISTOR, CARBON, 1.5 MEG ±10%, ¼W
R-221	31141-472	RESISTOR, CARBON, 4.7K ±10%, ½W
R-222	31141-154	RESISTOR, CARBON, 150K ±10%, ½W
R-223	31195-105	RESISTOR, CARBON, 1.0 MEG ±5%, ¼W
R-224	31195-105	RESISTOR, CARBON, 1.0 MEG ±5%, ¼W
R-225	31192-332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-226	32047-2	RESISTOR, POT LOC, ±30%, ¼W
R-227	31199-439	RESISTOR, METAL FILM, 249K ±1%, ¼W
R-228	31199-448	RESISTOR, METAL FILM, 309K ±1%, ¼W
R-229	31199-422	RESISTOR, METAL FILM, 165K ±1%, ¼W
R-230	31195-106	RESISTOR, CARBON, 10 MEG ±5%, ¼W
R-231	31141-124	RESISTOR, CARBON, 120K ±10%, ½W
R-232	31149-913	RESISTOR, CARBON, 91K ±5%, ½W
R-233	31192-105	RESISTOR, CARBON, 1 MEG ±10%, ¼W
R-234	31192-105	RESISTOR, CARBON, 1 MEG ±10%, ¼W
R-235	31192-124	RESISTOR, CARBON, 120K ±10%, ¼W
R-236		
R-237	31141-154	RESISTOR, CARBON, 150K ±10%, ½W
R-238	31141-473	RESISTOR, CARBON, 47K ±10%, ½W
R-239	31141-223	RESISTOR, CARBON, 22K ±10%, ½W
R-240	31192-333	RESISTOR, CARBON, 33K ±10%, ¼W
R-241	31192-333	RESISTOR, CARBON, 33K ±10%, ¼W
R-242	31149-154	RESISTOR, CARBON, 150K ±5%, ½W
R-243	31192-105	RESISTOR, CARBON, 1.0 MEG ±10%, ¼W
R-244	31141-681	RESISTOR, CARBON, 680 ±10%, ½W
R-245	31149-752	RESISTOR, CARBON, 7.5K ±5%, ½W
R-246	31192-681	RESISTOR, CARBON, 680 ±10%, ¼W
R-247	31195-471	RESISTOR, CARBON, 470 ±5%, ¼W
R-248	31195-471	RESISTOR, CARBON, 470 ±5%, ¼W
R-249	31195-102	RESISTOR, CARBON, 1K ±5%, ¼W
R-250	31195-102	RESISTOR, CARBON, 1K ±5%, ¼W
R-251	31135-223	RESISTOR, CARBON, 22K ±10%, 1W
R-252	32038-4	POTENTIOMETER, COURSE SELECTOR, 10K
R-253	31199-458	RESISTOR, METAL FILM, 392K ±1%, ¼W

MARK 8 ELECTRICAL PARTS Continued

Symbol	Part Number	Description
R-301	31192-330	RESISTOR, CARBON, 33 ±10%, ¼W
R-320	31192-473	RESISTOR, CARBON, 47K ±10%, ¼W
R-303	31192-683	RESISTOR, CARBON, 68K ±10%, ¼W
R-304	31192-561	RESISTOR, CARBON, 560 ±10%, ¼W
R-305	31192-101	RESISTOR, CARBON, 100 ±10%, ¼W
R-306		
R-307	31192-473	RESISTOR, CARBON, 47K ±10%, ¼W
R-308	31192-330	RESISTOR, CARBON, 33 ±10%, ¼W
R-309	31192-223	RESISTOR, CARBON, 22K ±10%, ¼W
R-310	31192-473	RESISTOR, CARBON, 47K ±10%, ¼W
R-311	31192-472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-312	31192-150	RESISTOR, CARBON, 15 ±10%, ¼W
R-313	31192-150	RESISTOR, CARBON, 15±10%, ¼W
R-314	31192-223	RESISTOR, CARBON, 22K ±10%, ¼W
R-315	31192-681	RESISTOR, CARBON, 680 ±10%, ¼W
R-316	31192-101	RESISTOR, CARBON, 100 ±10%, ¼W
R-317	31141-102	RESISTOR, CARBON, 1K ±10%, ½W
R-318	31192-223	RESISTOR, CARBON, 22K ±10%, ¼W
R-319	31141-101	RESISTOR, CARBON, 100 ±10%, ½W
R-320	31141-151	RESISTOR, CARBON, 150 ±10%, ½W
R-321	31192-473	RESISTOR, CARBON, 47K ±10%, ¼W
R-322	31141-101	RESISTOR, CARBON, 100 ±10%, ½W
R-323	31141-103	RESISTOR, CARBON, 10K ±10%, ½W
R-324	31192-473	RESISTOR, CARBON, 47K ±10%, ¼W
R-325	31192-101	RESISTOR, CARBON, 100 ±10%, ¼W
R-326		
R-327	31192-561	RESISTOR, CARBON, 560 ±10%, ¼W
R-328	31192-561	RESISTOR, CARBON, 560 ±10%, ¼W
R-329	31141-332	RESISTOR, CARBON, 3.3K ±10%, ½W
R-330	31192-473	RESISTOR, CARBON, 47K ±10%, ¼W
R-401	31192-104	RESISTOR, CARBON, 100K ±10%, ¼W
R-402	31192-562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R-403	31192-224	RESISTOR, CARBON, 220K ±10%, ¼W
R-404	31192-154	RESISTOR, CARBON, 150K ±10%, ¼W
R-405	31192-223	RESISTOR, CARBON, 22K ±10%, ¼W
R-406	31192-331	RESISTOR, CARBON, 330 ±10%, ¼W
R-407	31192-122	RESISTOR, CARBON, 1.2K ±10%, ¼W
R-408	31192-152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-409	31205-2	THERMISTOR, 100 ±10% -25°C
R-410	31141-220	RESISTOR, CARBON, 22 ±10%, ½W
R-411	31141-331	RESISTOR, CARBON, 330 ±10%, ½W
R-412	31135-152	RESISTOR, CARBON, 1.5K ±10%, 1W
R-413	31141-331	RESISTOR, CARBON, 330 ±10%, ½W
R-414	31141-221	RESISTOR, CARBON, 220 ±10%, ½W
R-415	31141-104	RESISTOR, CARBON, 100K ±10%, ½W
R-416	31135-820	RESISTOR, WIREWOUND, 82 ±10%, 1W
R-417	31141-SEL.	RESISTOR, CARBON, SEL., ±10%, ½W
R-501	31136-471	RESISTOR, CARBON, 470 ±10%, 2W
R-502	31190-6	RESISTOR, WIREWOUND, 10 ±10%, 7W
R-503	31141-229	RESISTOR, CARBON, 2.2 ±10%, ½W
R-504	31162-3	RESISTOR, WIREWOUND, 500 ±5%, 5W
R-505	31141-102	RESISTOR, CARBON, 1K ±10%, ½W
R-506	31211-1	RESISTOR, WIREWOUND, 220 ±5%, 3W

MARK 8 ELECTRICAL PARTS Continued

Symbol	Part Number	Description
S-101	61438-101	SWITCH, HFIF
S-102		SWITCH, (PART OF R-129)
S-102		SWITCH, (PART OF L-307)
S-201	61445-101	SWITCH, OMNI-LOC., MHz
S-202	61459-101	SWITCH, OMNI-LOC., KHz
S-301	61438-101	SWITCH, AVC TIME CONSTANT
S-302	61455-101	CRYSTAL SWITCH, REC + XMIT HFO
S-401	61528-1	SWITCH, IDENT. SPST SLIDE
T-101	11481-1	TRANSFORMER, HF IF 17.1 MHz
T-102	11482-1	TRANSFORMER, HF IF 9.1 MHz
T-103	11659-102	TRANSFORMER, INPUT, 4.0 MHz
T-104	11657-102	TRANSFORMER, INTERSTAGE, 4.0 MHz
T-105	11658-102	TRANSFORMER, OUTPUT, 4.0 MHz
T-201	11662-101	TRANSFORMER, OMNI OUTPUT
T-202	11661-2	TRANSFORMER, DESCRIMINATOR, 10 KHz
T-203	11663-101	TRANSFORMER, AUDIO 30 Hz
T-401	11710-1	TRANSFORMER, AUDIO DRIVER
T-402	11709-3	TRANSFORMER, MODULATION
T-501	11697-3	TRANSFORMER, POWER, 14 VOLT
V-1	6KE8	TUBE
V-2	6KE8	TUBE
V-3	6GH8A	TUBE
V-4	6GH8A	TUBE
V-5	6KE8	TUBE
V-6	6GH8A	TUBE
V-7	12AU7A	TUBE
V-8	6GH8A	TUBE
V-9	6GH8A	TUBE
V-10	8106	TUBE
V-11	7701	TUBE
XT-301	72020-1	CRYSTAL QUARTZ 62.76575 MHz 5th MODE FREQUENCY
XT-302	72020-2	CRYSTAL QUARTZ 63.26575 MHz 5th MODE FREQUENCY
XT-303	72020-3	CRYSTAL QUARTZ 63.76575 MHz 5th MODE FREQUENCY
XT-304	72020-4	CRYSTAL QUARTZ 64.26575 MHz 5th MODE FREQUENCY
XT-305	72020-5	CRYSTAL QUARTZ 64.76575 MHz 5th MODE FREQUENCY
XT-306	72020-6	CRYSTAL QUARTZ 65.26575 MHz 5th MODE FREQUENCY
XT-307	72020-7	CRYSTAL QUARTZ 65.76575 MHz 5th MODE FREQUENCY
XT-308	72020-8	CRYSTAL QUARTZ 66.26575 MHz 5th MODE FREQUENCY
XT-309	72020-9	CRYSTAL QUARTZ 66.76575 MHz 5th MODE FREQUENCY
XT-310	72020-10	CRYSTAL QUARTZ 67.26575 MHz 5th MODE FREQUENCY
XT-311	72020-11	CRYSTAL QUARTZ 67.76575 MHz 5th MODE FREQUENCY
XT-312	72020-12	CRYSTAL QUARTZ 68.26575 MHz 5th MODE FREQUENCY
XT-313	72020-13	CRYSTAL QUARTZ 68.76575 MHz 5th MODE FREQUENCY
XT-314	72020-14	CRYSTAL QUARTZ 69.26575 MHz 5th MODE FREQUENCY
XT-315	72020-15	CRYSTAL QUARTZ 69.76575 MHz 5th MODE FREQUENCY
XT-316	72020-16	CRYSTAL QUARTZ 61.0500 MHz 5th MODE FREQUENCY
Z-1	11454-1	CHOKE, FERRITE BEAD

6.1 GENERAL

This Section contains the schematics for the Mark 8. Included in this section is a three view figure of the OMNI Board, a schematic for both the Receiver OMNI Section, and the Transmitter Audio Power Supply Section.

To the left of each schematic a voltage and resistance chart is provided for test reference.

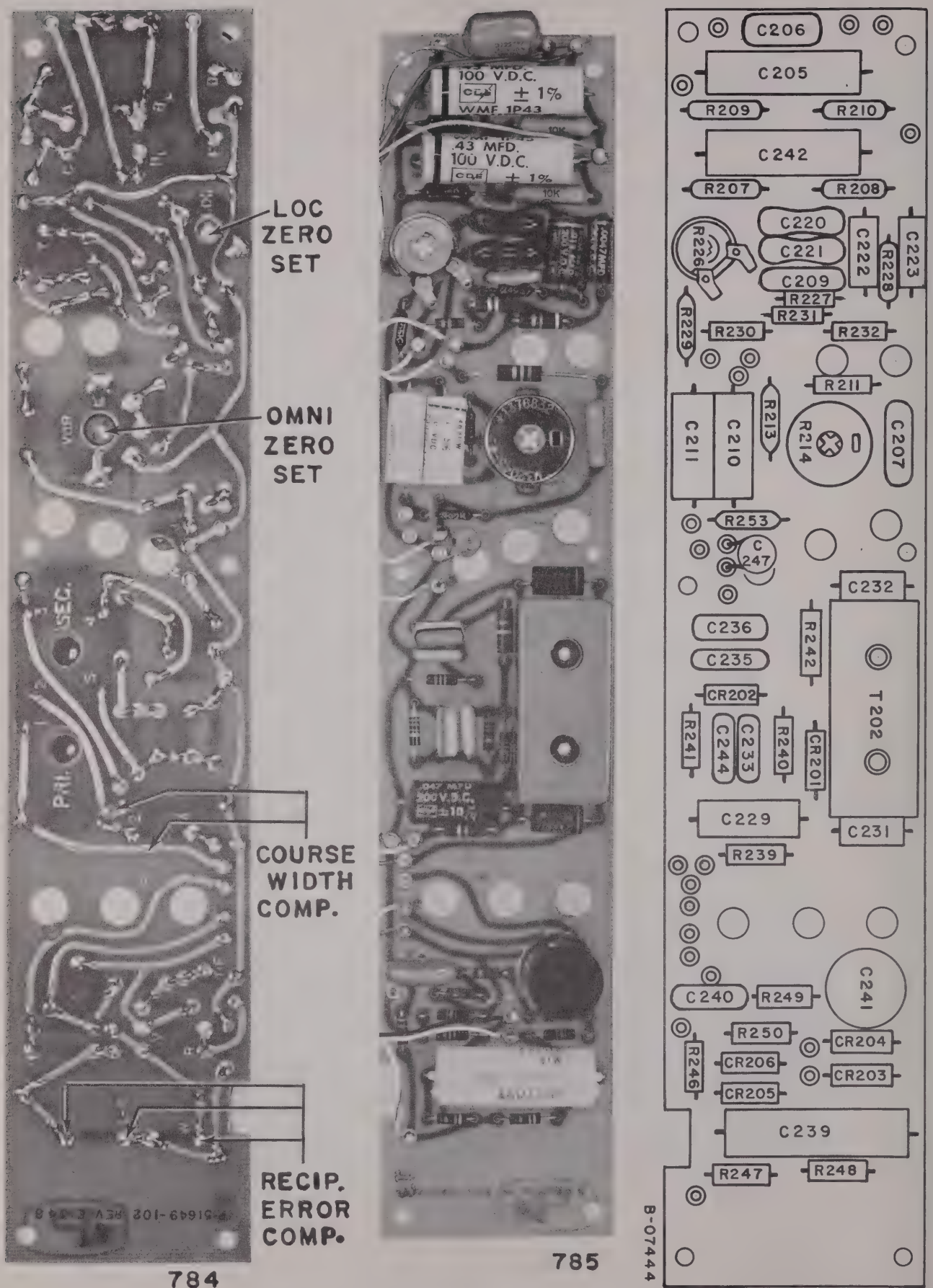


Figure 6-1 OMNI PRINTED CIRCUIT BOARD

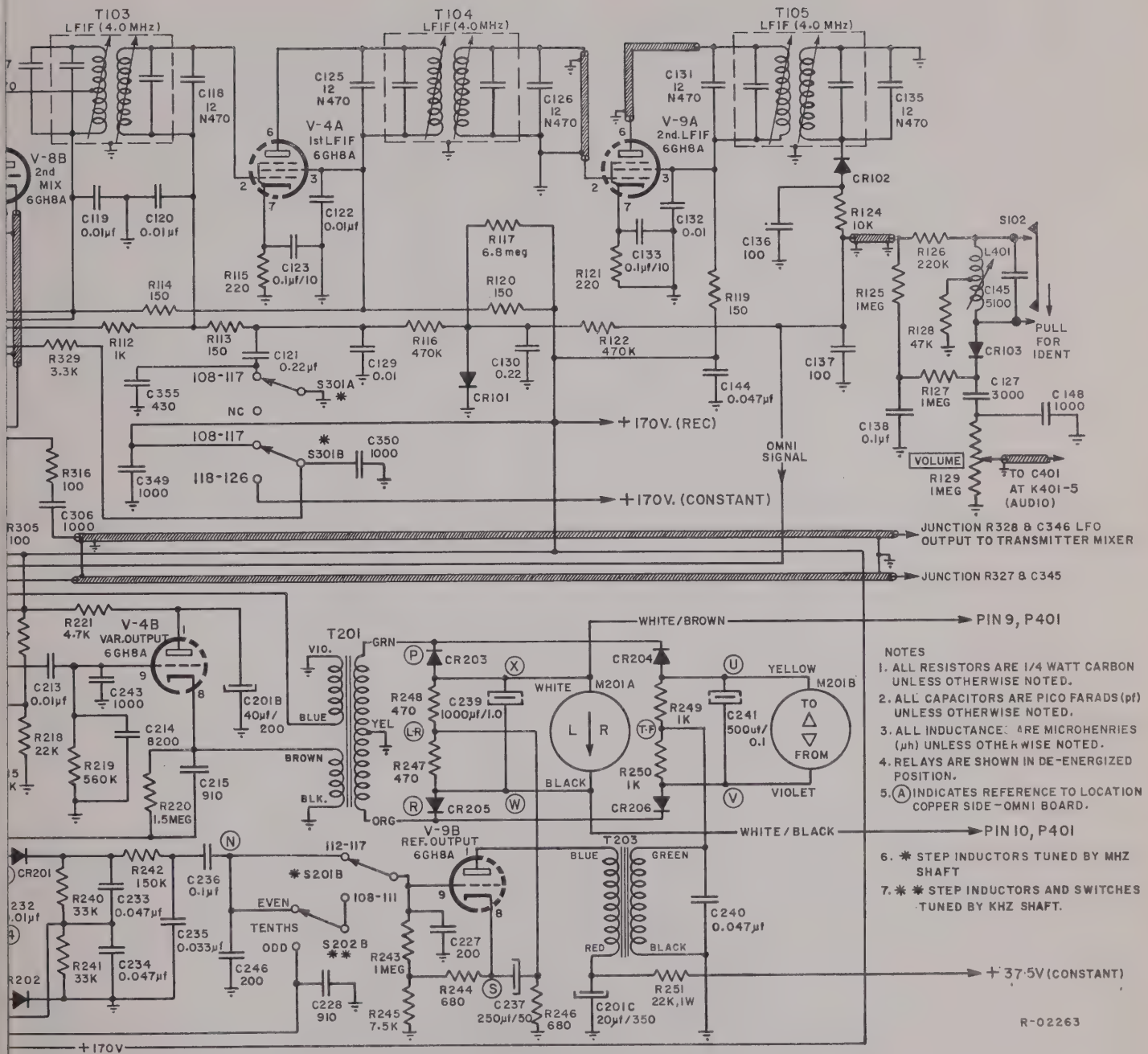


Figure 6-2 MARK 8, RECEIVER/OMNI SCHEMATIC

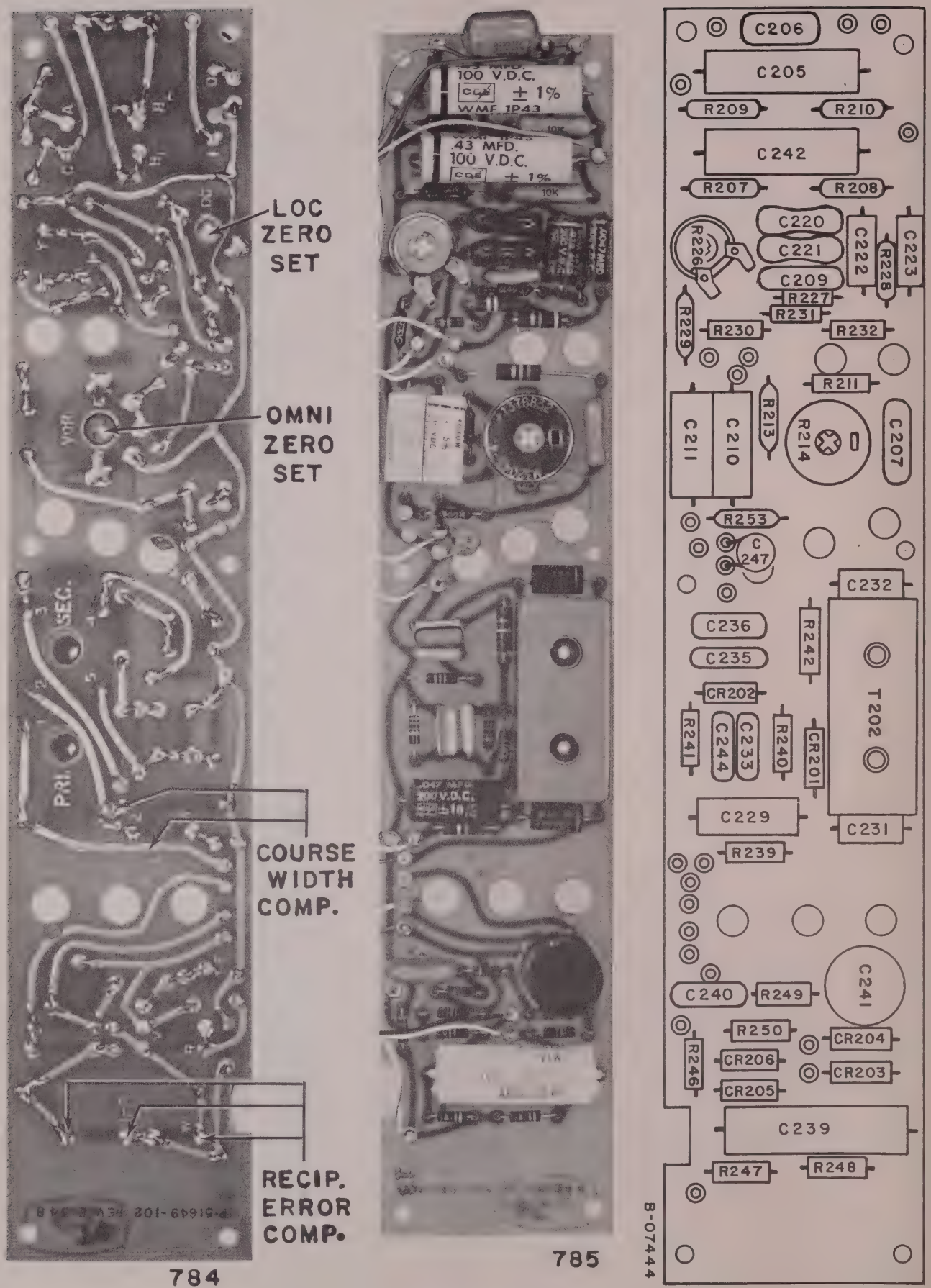


Figure 6-1 OMNI PRINTED CIRCUIT BOARD

VOLTAGE CHART

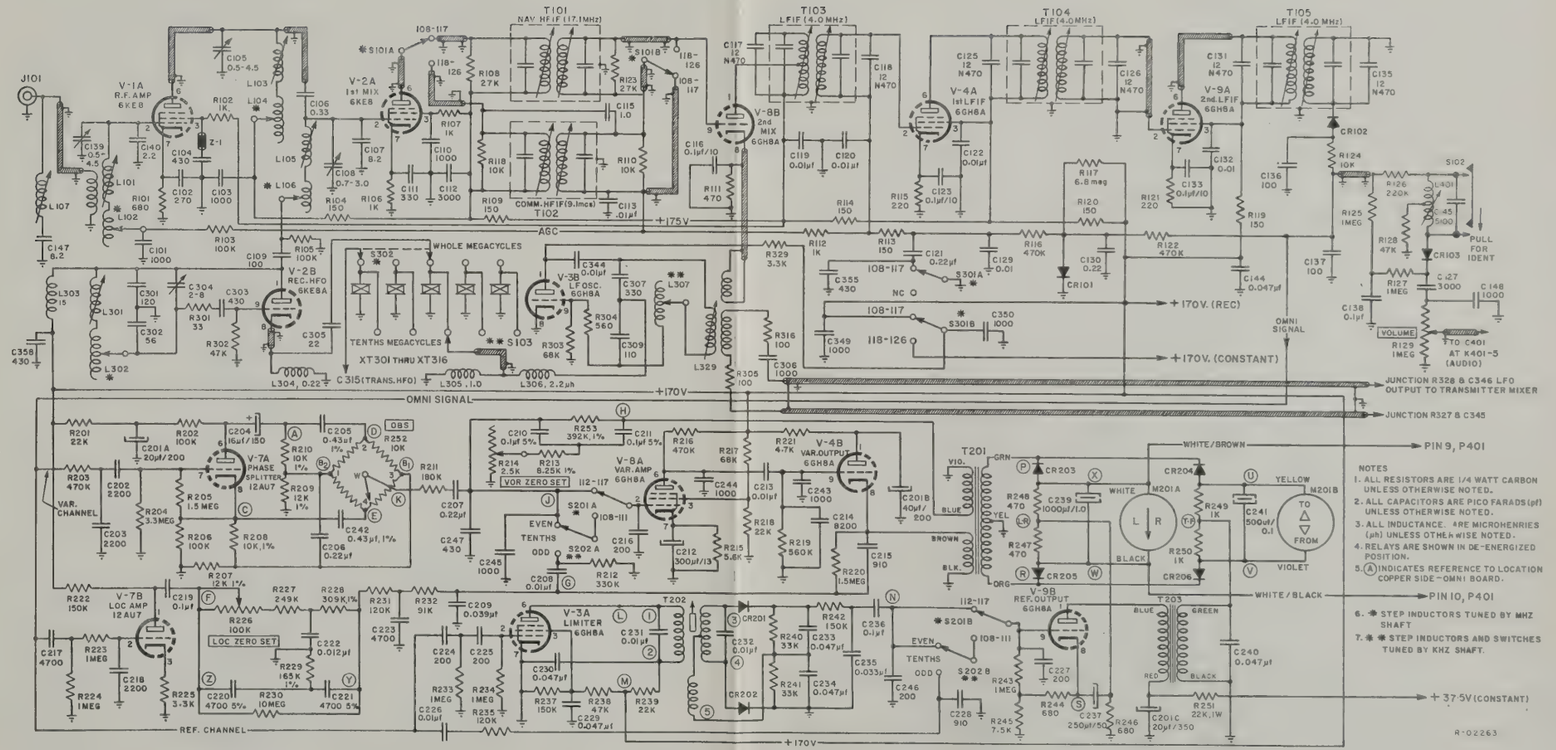
TUBE	FUNCTION	TYPE	TUBE PIN								
			1	2	3	4	5	6	7	8	9
V-1A	RF Amp	6KE8	-	0.35	160	6.8	0	160	2.2	-	-
V-2A V-2B	1st Mix Rec HFO	6KE8	165	0.35	160	13.75	6.8	160	4.0	-	-3.0
V-3A V-3B	Limiter LFO	6GH8A	125	-1.0 1.0	60	6.8	13.75	50 20	-	-	2.5
V-4A V-4B	1st LFIF Var Out	6GH8A	120	1.0	165	0	6.8	165 3.5	3.0	1.8 *33°	- 0.2 *25°
V-7A V-7B	Phase Splitter Loc Amp	12AU7A	50 10.0	- 1.0	2.5 0.38	0	13.75	75 1.7 *7°	6.5 2.0 *174°	10.0 1.7 *187°	0
V-8A V-8B	Var Amp 2nd Mix	6GH8A	160	- 0.15	35	13.75	6.8	65 3.5 *6°	1.6	3.8	-
V-9A V-9B	2nd LFIF Ref Output	6GH8A	230 3.0 *178°	-	165	0	6.8	165	2.8	50 2.5 *48°	35 5.0 *45°

*NOTE: All OMNI voltages measured with 13.75 vac applied to unit, course selector at 0°, 500 μv OMNI signal applied. AC measurements are those values underlined above. All values are positive + (plus unless otherwise noted. For phase angle measurement method, see Figure 4-6.

RESISTANCE CHART

TUBE	FUNCTION	TYPE	TUBE PIN								
			1	2	3	4	5	6	7	8	9
V-1A	RF Amp	6KE8	-	1 meg	1.5K(1)	-	-	600(1)	680	-	-
V-2A V-2B	1st Mix HFO	6KE8	0.5(1)	100K	1.5K(1)	-	-	450(1)	1K	0	47K
V-3A V-3B	Limiter LFO	6GH8A	3.3K(1)	22K	47K(1)	-	-	22K(1)	0	0	68K
V-4A V-4B	1st LFIF Var Out	6GH8B	4.7K(1)	850K	150(1)	-	-	150(1)	220	150	560K
V-7A V-7B	Phase Splitter Loc Amp	12AU7	150K(1)	2 meg	3.3K	-	-	127K(1)	1 meg	15K	-
V-8A V-8B	Var Amp 2nd Mix	6GH8A	300(1)	-	400K	-	-	470K(1)	5.6K	470	850K
V-9A	2nd LFIF	6GH8A	22K(2)	0	150(1)	-	-	150(1)	220	8.5K	1 meg

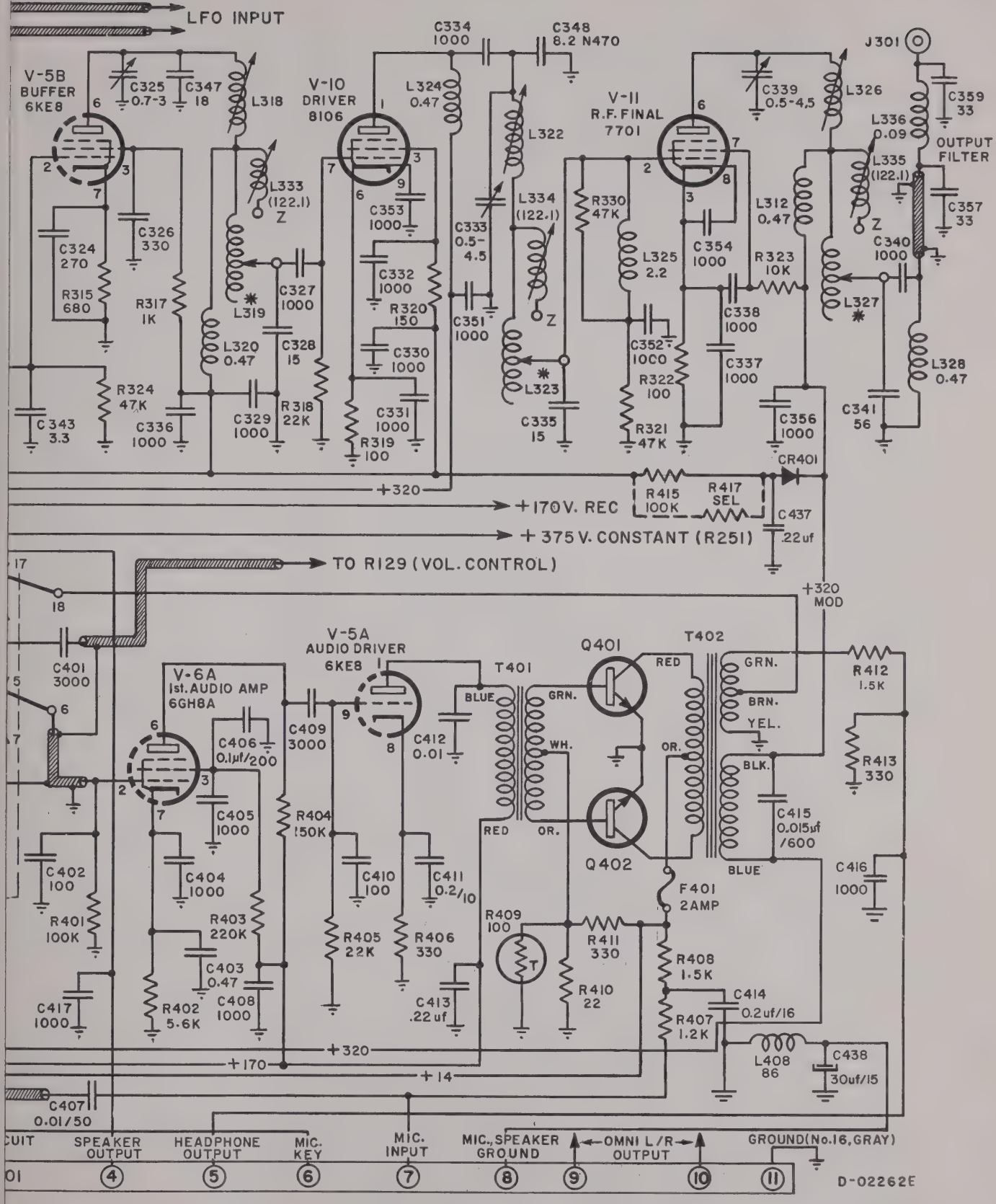
NOTES: All resistances measured to ground unless otherwide noted.
(1) Measured to C504C (Figure 6-3)
(2) Measured to C504B (Figure 6-3)



NOTES
1. ALL RESISTORS ARE 1/4 WATT CARBON UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE PICO FARADS (pf) UNLESS OTHERWISE NOTED.
3. ALL INDUCTANCE ARE MICROHENRIES (μh) UNLESS OTHERWISE NOTED.
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. (A) INDICATES REFERENCE TO LOCATION COPPER SIDE - OMNI BOARD.
6. * STEP INDUCTORS TUNED BY MHZ SHAFT
7. * * STEP INDUCTORS AND SWITCHES TUNED BY KHZ SHAFT.

R-02263

Figure 6-2 MARK 8, RECEIVER/OMNI SCHEMATIC



6-3 MARK 8, TRANSMITTER/MODULATOR/POWER SUPPLY SCHEMATIC

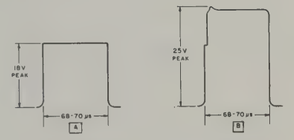
VOLTAGE CHART

TUBE	FUNCTION	TYPE	TUBE PIN								
			1	2	3	4	5	6	7	8	9
V-1B	HFO Dblr	6KE8	175	-	-	-	-	-	-	7.5	-
V-5B	Audio Driver Trans. Buffer	6KE8	160 23	-	170	6.9	13.75	175	3.5	2.5	- 1.5
V-6A V-6B	1st Aud. Amp HFO	6GH8A	175	- 0.15	120	0	6.9	80 3.9	4.5	-	-4.5
V-10	Trans. Driver	8106	325	-	165	0	13.75	3.5	-	-	3.5
V-11	RF Final Amp	7701	-	-40	4.0	0	13.75	315	260	4.0	-

NOTE: AC measurements are those values underlined above. These AC voltage obtained with 1.3 vac present at detector output. All values are positive + (plus, unless otherwise noted).

TRANS.	FUNCTION	PART NO.	EMITTER	BASE	COLLECTOR
Q-301	Bal. Mix	75568-2	.02	0.3	6.8
Q-302	Bal. Mix	75568-2	.02	0.3	6.8
Q-401	Audio Transistor	75576-1	0	0.45	14
Q-402	Audio Transistor	75576-1	0	0.45 0.65	14 7.5
Q-501	Pwr Transistor	75564-2		A	B
Q-502	Pwr Transistor	75564-2		A	B

TEST POINT	VOLTAGES
Junction R-502 & C-503	-8.0V RECEIVE FUNCTION -7.5V TRANSMIT FUNCTION
Junction R-501 & C-502	13.5V RECEIVE 13.1V TRANSMIT
Junction Diode Bridge & R-504	385V RECEIVE 375V TRANSMIT
Junction R-504 & R-505	380V RECEIVE 325V TRANSMIT
Junction R-506 & C-504C	170V RECEIVE 175V TRANSMIT



Q501/Q502 Base Waveforms

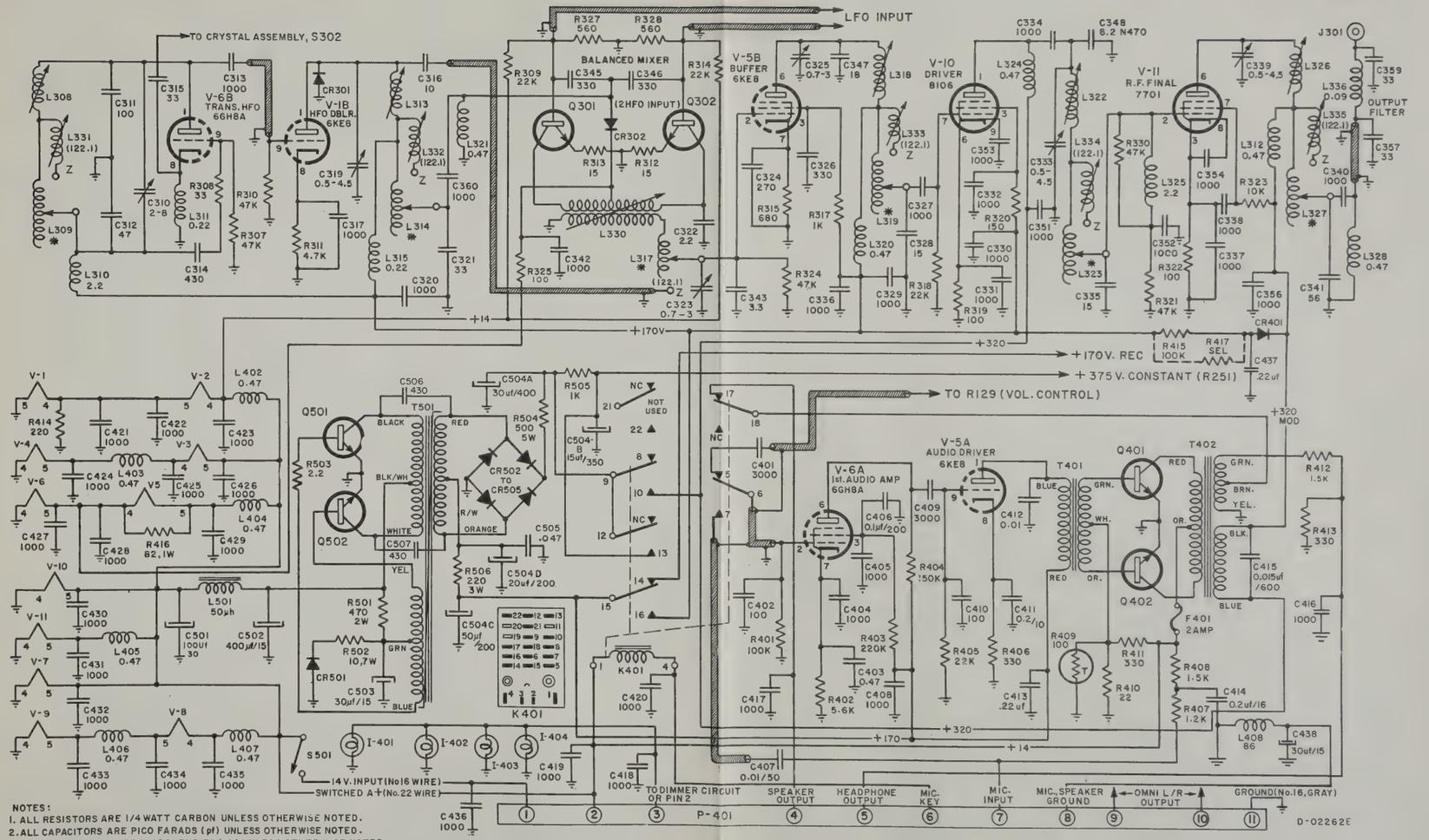
Q501/Q502 Collector Waveforms

RESISTANCE CHART

TUBE	FUNCTION	TYPE	TUBE PIN								
			1	2	3	4	5	6	7	8	9
V-1B	HFO Dblr	6KE8	-	-	-	-	-	-	-	4.7K	47K
V-5A V-5B	Audio Driver Trans. Buffer	6KE8	220(1)	47K	-	0	0	-	680	330	22K
V-6A V-6B	1st Aud. Amp HFO	6GH8A	-	100K	220K(1)	0	0	150K(1)	5.6K	0	47K
V-10	Trans. Driver	8106	0(2)	-	-	0	0	100	22K	-	100
V-11	RF Final Amp	7701	-	47K	100	0	0	200(2)	10K(2)	100	-

TRANS.	FUNCTION	PART NO.	EMITTER	BASE	COLLECTOR
Q-301	Bal. Mix	75568-2	15	560	100
Q-302	Bal. Mix	75568-2	15	560	100
Q-401	Audio Transistor	75576-1	0	22	3
Q-402	Audio Transistor	75576-1	0	22	3
Q-501	Pwr Transistor	75564-2	0	8	1
Q-502	Pwr Transistor	75564-2	0	8	1

NOTE: All resistances measured to ground unless otherwise noted.
(1) Measured to C-504C
(2) Measured to junction of C-415 and bluewire of T-402



NOTES:
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3. ALL INDUCTANCES ARE MICROHENRIES (µh) UNLESS OTHERWISE NOTED.
4. RELAYS ARE SHOWN IN DE-ENERGIZED POSITION.
5. ✱ STEP INDUCTORS TUNED BY MC SHAFT.
Z - CONTACTS ACTIVATED BY INDUCTOR ROTOR 108.0 THRU 117.9 MHz TO PROVIDE FLIGHT SERVICE TRANSMIT OPERATION ON 122.1 MHz.

Figure 6-3 MARK 8, TRANSMITTER/MODULATOR/POWER SUPPLY SCHEMATIC

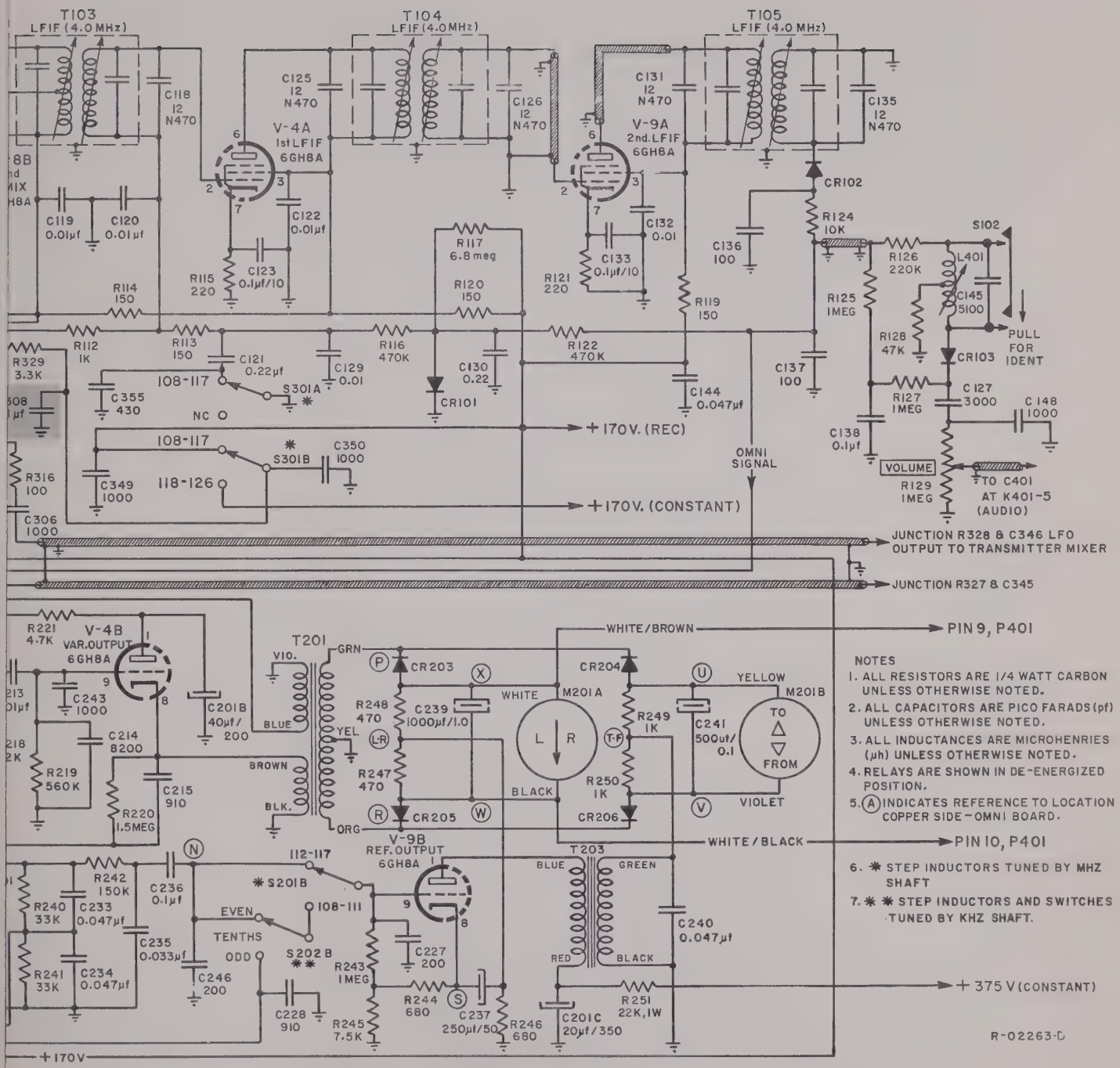


Figure 6-2A. MARK 8, RECEIVER/OMNI SCHEMATIC FOR CN193A4.

SUPPLEMENT No. 1
to
MARK 8
Maintenance Manual No. 3082-600

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN193A2
Added C308 21291-0006 CAPACITOR, Ceramic Disc, 0.01μf, 500V GMV

CN193A3
Mechanical changes only:
Changed 51688-0001 OBS Pulley Shaft TO 51673-0101 Shaft, Metal
Changed 51682-0001 Ident. VOL. Ext. Shaft TO 51674-0102 Shaft, Metal

CN193A4
Chassis number changed for internal audit control purposes only.

Other Changes:
Added 1931-114 Crystal & Fractional MHz Detent Assy (See Fig. 4-3)
Added 1931-558 Output Transistors/Heat Sink Assy (See Fig. 4-9)
Change Q301 75568-0003 Delete 2N3563, add NARCO SELECTED PART
Change Q302 75568-0003 Delete 2N3563, add NARCO SELECTED PART

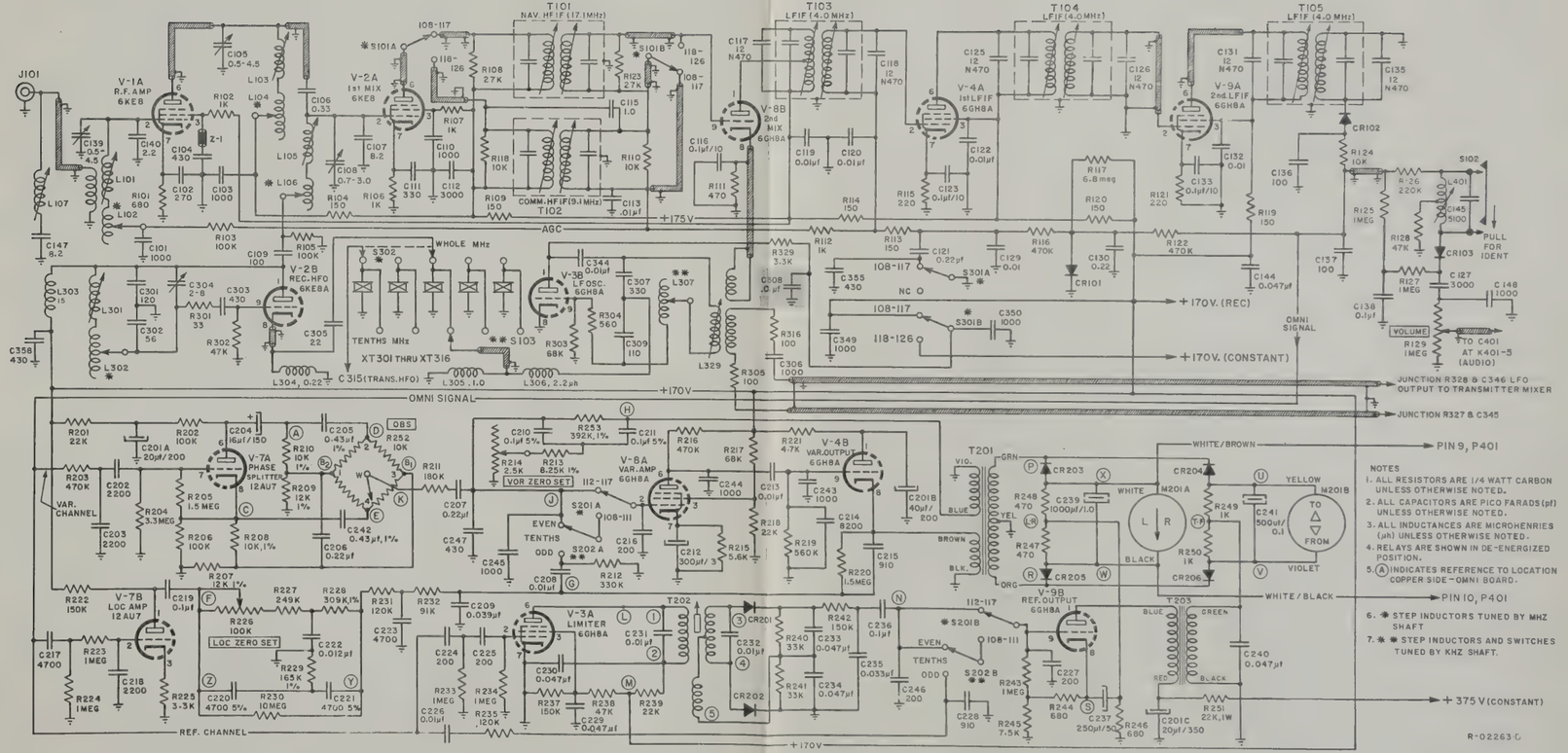


Figure 6-2A. MARK 8, RECEIVER/OMNI SCHEMATIC FOR CN193A4.

NARCO AVIONICS MARK 8

CN193A5

Changed and Relocated

R414 was 31141-221 con

R414 Now 31175-26 Re

Changed V1B was 6KE8

V1B Now 5KE8

Added C361 24516-689 Capacit

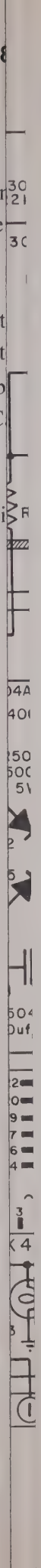
Added C362 24516-689 Capacit

Changed C414 was 24515-11 Cap

C414 Now 23094-179 C

CN193A6

Added 54514-1 Spring Groundi



CN193A5

Changed and Relocated

R414 was 31141-221 connected across C421

R414 Now 31175-26 Resistor, wirewound, 27. ±10%, 5w connected across C424

Changed V1B was 6KE8

V1B Now 5KE8

Added C361 24516-689 Capacitor Disc. 6.8pf ±10%, 500v

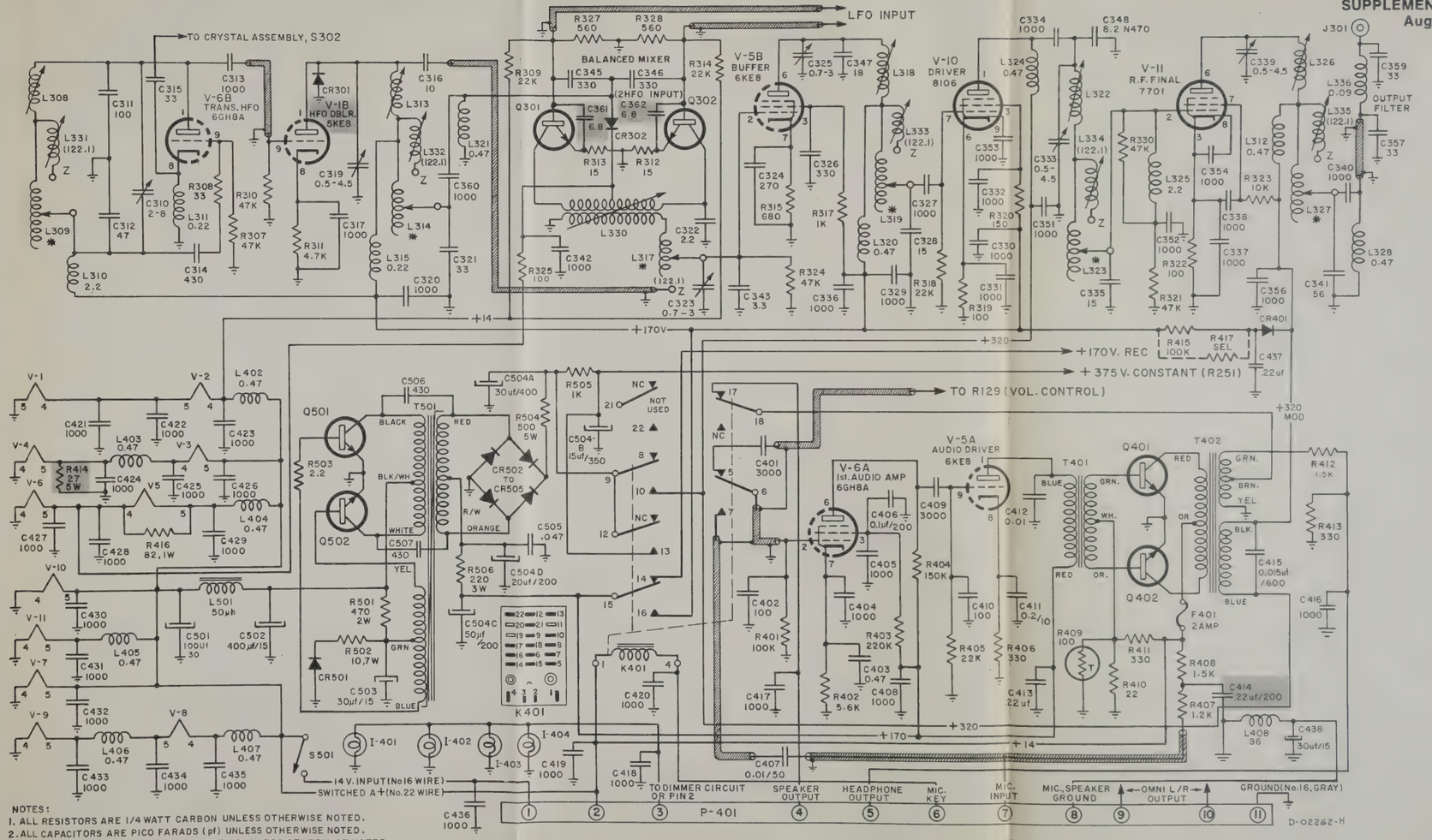
Added C362 24516-689 Capacitor, Disc, 6.8pf ±10%, 500v

Changed C414 was 24515-11 Capacitor, Disc, 0.2uf ±80% -20%, 16v

C414 Now 23094-179 Capacitor, Mylar, .22uf ±10%, 200v

CN193A6

Added 54514-1 Spring Grounding (near tube V11) qty 2 (total 3 in unit)



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5. ✱ STEP INDUCTORS TUNED BY MC SHAFT.
Z-CONTACTS ACTIVATED BY INDUCTOR ROTOR 108 0 THRU 117.9 MHz TO PROVIDE FLIGHT SERVICE TRANSMIT OPERATION ON 122.1 MHz.

FIGURE 6-3A. MARK 8 TRANSMITTER/MODULATOR/POWER SUPPLY SCHEMATIC, CN193A5/A6.

NARCO AVIONICS MARK

CN193A5

Changed and Relocated

R414 was 31141-221 co

R414 Now 31175-26 Re

Changed V1B was 6KE8

V1B Now 5KE8

Added C361 24516-689 Capacit

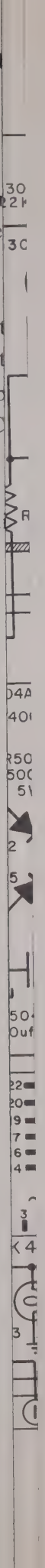
Added C362 24516-689 Capacit

Changed C414 was 24515-11 Cap

C414 Now 23094-179 C

CN193A6

Added 54514-1 Spring Ground



CN193A5

Changed and Relocated

R414 was 31141-221 connected across C421

R414 Now 31175-26 Resistor, wirewound, 27. ±10%, 5w connected across C424

Changed V1B was 6KE8

V1B Now 5KE8

Added C361 24516-689 Capacitor Disc. 6.8pf ±10%, 500v

Added C362 24516-689 Capacitor, Disc, 6.8pf ±10%, 500v

Changed C414 was 24515-11 Capacitor, Disc, 0.2uf ±80% -20%, 16v

C414 Now 23094-179 Capacitor, Mylar, .22uf ±10%, 200v

CN193A6

Added 54514-1 Spring Grounding (near tube V11) qty 2 (total 3 in unit)

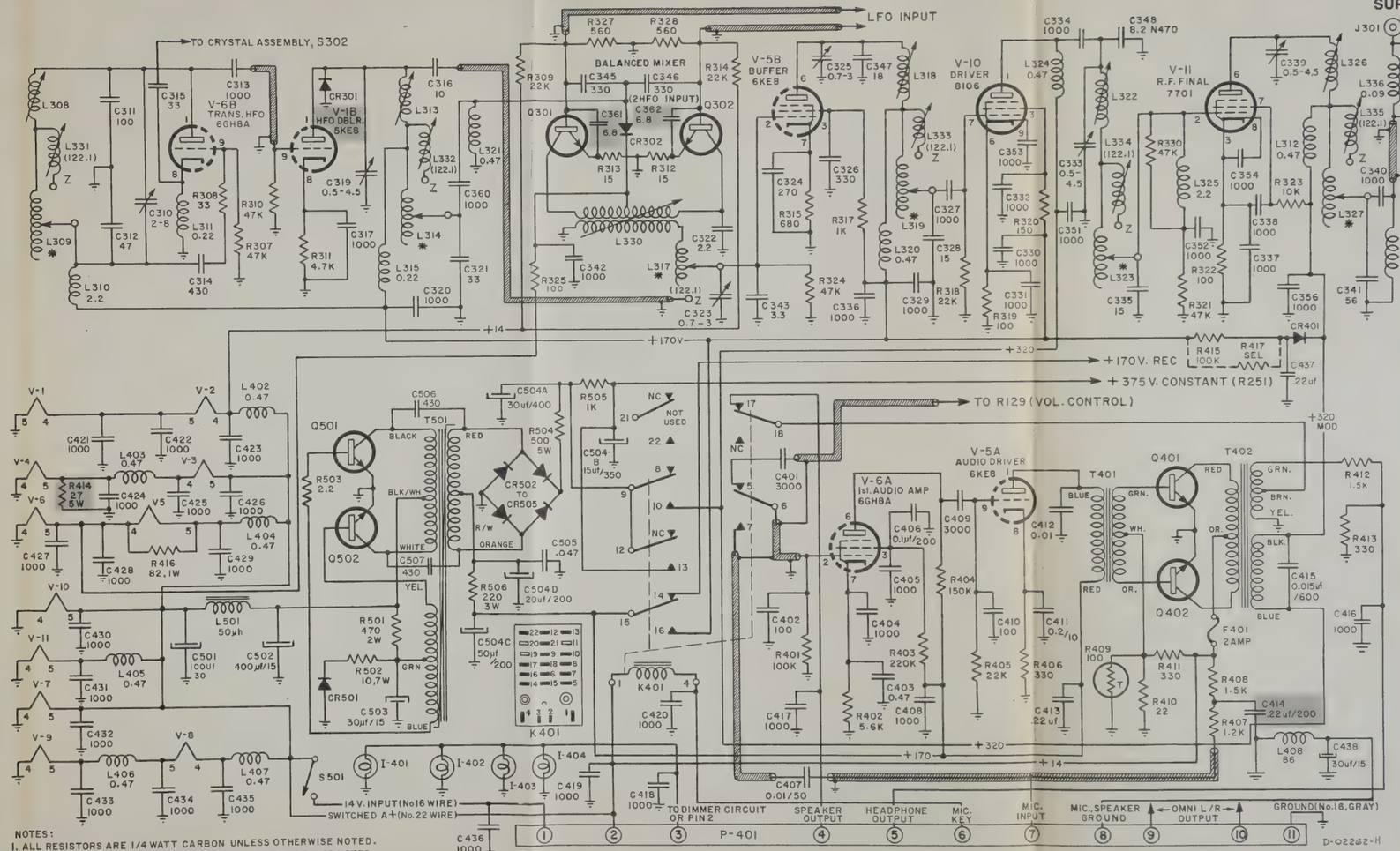


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FIGURE 6-3A. MARK 8 TRANSMITTER/MODULATOR/POWER SUPPLY SCHEMATIC, CN193A5/A6.

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MARK-12
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL

FOR PANEL UNITS:

CN89-A. Original Manual thru page 58.
CNP89-A. Original Manual thru page 58.

CN89-B. Supplement No. 1, page 59, etc.
CNP89-B. Supplement No. 1, page 59, etc.

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DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

3075-600
Supplement No. 4.

Printed in U.S.A.

April, 1965

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MARK-12
VHF Transceiver

with

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and

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CNP89-C & D. Supplement No. 2, page 71, etc.

CN89-E & F. Supplement No. 3, page 91, etc.
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CNPB89-B. Supplement No. 2, page 71, etc.

CNPA89-C & D. Supplement No. 3, page 91, etc.
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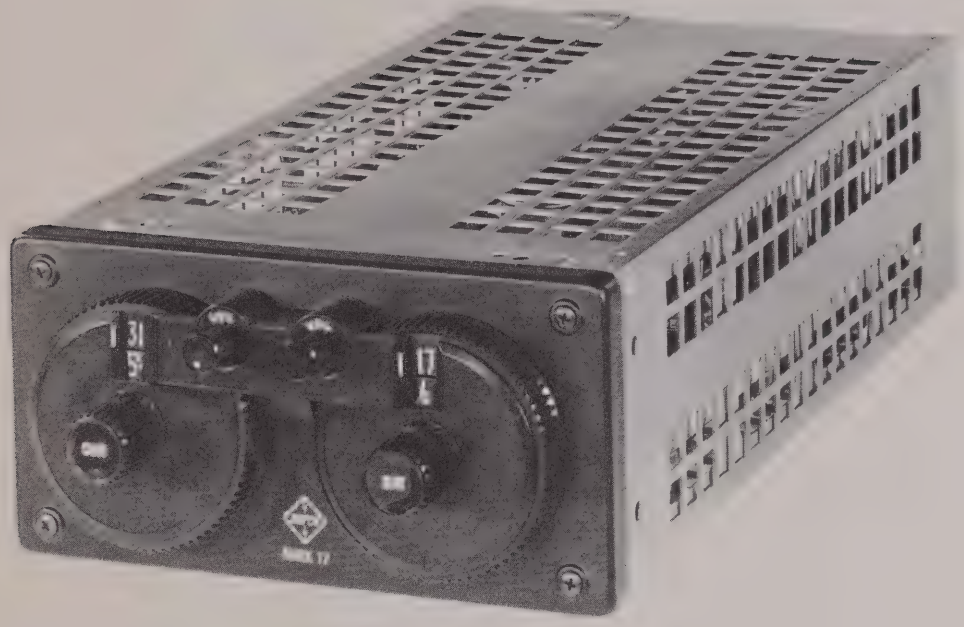

MARK-12
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL

CN89-A
CNP89-A
CNPA89-A
CNPB89-A

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APRIL, 1963

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SECTION 1
GENERAL INFORMATION

1-A. INTRODUCTION.

The ***narco*** MARK 12 Equipment comprises a VHF Communications Transceiver and a VHF Navigation Receiver in a panel-mounted unit, and a remote-mounted Modulator-Power Unit.

1-A,1. Panel Unit.

The VHF Transceiver is designed to be used as a primary communications apparatus. It is controlled by the left hand frequency selector of the Panel Unit. It is available with either 90 or 360 crystal controlled channels. A kit of crystals is obtainable from ***narco*** to enable a 90 channel MARK 12 to be converted to operate on all 360 channels at any later date. Single-channel-simplex (SCS) operation is provided as both receiver and transmitter are channeled by the same selector.

A 100 channel VHF Navigation Receiver is controlled by the right hand frequency selector, to provide Omni Range Navigation when used with the ***narco*** VOA-6 Omni Converter. When used with an omni converter such as the ***narco*** VOA-4 or VOA-5, complete VOR/LOC navigation reception is available.

Glide Slope channel selector switches are included as part of the Navigation Receiver. In order to make connection between these switches and any standard Glide Slope Receiver it is necessary to install a Cable and Connector Kit in the Navigation Receiver.

1-A,2. Modulator-Power Unit.

A remote-mounted Unit, the T12MP-12 or T24MP-12, contains the power supply and audio-modulator. An auxiliary audio input circuit is provided so that one or more other radio equipments may be connected to operate through the ***narco*** MARK-12 Audio Amplifier. This audio input circuit is designed for a level of 50 milliwatts from a 300 ohm source.

The T12MP-12 and T24MP-12 Units have been designed to be mounted either horizontally or vertically, by means of the mounting base supplied.

1-B. SPECIFICATIONS.

1-B,1. Communications Transceiver.

a. Frequency Range, Domestic Equipment.

90 Channel Equipment:
118.0 thru 126.9 megacycles.
(100 Kc Channel Spacing)

360 Channel Equipment:
118.00 thru 135.95 megacycles.
(50 Kc Channel Spacing)

b. Frequency Range, Export Equipment.

100 Channel Equipment:
117.0 thru 126.9 megacycles.
(100 Kc Channel Spacing)

380 Channel Equipment:
117.00 thru 135.95 megacycles.
(50 Kc Channel Spacing)

1-B,2. Communications Transmitter.

Power Output:
Nominal 8 to 10 watts.

Sidetone:
50 Milliwatts.

Modulation:
70% minimum, 85% before clipping.

Microphone:
Carbon, or noise-cancelling carbon (low impedance) type to be used.

Duty:
Maximum 20%.

1-B,3. Communications Receiver.

Sensitivity:
1.5 microvolts maximum for 6 db signal + noise to noise ratio.

Overall Selectivity:
6 db (nose),
32 Kc minimum bandwidth.
60 db (skirt), 90 Kc maximum bandwidth.

Image Rejection:
At least 60 db.

AVC:
4 db from 10 to 10,000 microvolts.

Audio Output:
6 to 8 watts.

1-B,4. Navigation Receiver.

Frequency Range:
108.0 thru 117.9 megacycles
(100 Kc Channel Spacing).

Sensitivity:
1.0 microvolt for 6 db signal + noise to noise ratio.

Overall Selectivity:
6 db (nose), 42 Kc minimum bandwidth.
60 db (skirt), 190 Kc maximum bandwidth.

Image Rejection:
At least 70 db.

AVC:
4 db from 10 to 10K microvolts.

Audio Output:
6 watts.

1-B,5. General.

a. Size:

Panel Unit: See Figure 9, page 36.
Modulator-Power Unit: See Figure 10, page 36.

b. Weight:

Panel Unit: 5.1 pounds.
Modulator-Power Unit: 3.9 pounds.

c. Power Required:

At 13.75 Volts, 5.2 amps Receive,
9.5 amps Transmit.

At 27.50 Volts, 2.7 amps Receive,
4.9 amps Transmit.

SECTION 2
INSTALLATION

2-A. INTRODUCTION.

The *narco* MARK-12 Equipment, except for Antennas and Accessories, is contained in a Panel Unit and a Modulator-Power Unit.

The Panel Unit is normally installed in or near the aircraft instrument panel, for convenient direct operation by the pilot. The Panel Unit Case is usually installed permanently. When this is done, the Panel Unit Assembly may be installed or removed by operating the "Airloc" fastener and attaching or detaching the cables, by means of the connectors provided, at the rear of the Assembly.

The Modulator-Power Unit may be installed in a convenient location at an interconnecting cable distance of up to 16 feet. It is well to avoid locations which are subject to extremes of temperature, dirt or moisture. The unit is provided with a mounting base. This base is usually installed permanently. The Modulator-Power Unit, with its cover intact, may then be installed or removed by tightening or loosening (without removing) the four mounting screws and connecting or disconnecting a single cable connector.

The Interconnecting Cable, with provision for accessory connections, may be purchased from *narco* in 8 or 16 foot lengths or may be fabricated to suit the particular installation.

Information concerning installation details, power requirements, accessory connections, antennas, etc., are contained in succeeding paragraphs in this section, with appropriate references to the illustrations in Section 6.

2-B. UNITS and ACCESSORIES SUPPLIED.

1. *narco* MARK-12 Panel Unit.
   a. Domestic: 90 or 360 Communication Channels, as ordered.
   b. Export: 100 or 380 Communication Channels, as ordered.
2. Power Audio Unit.

   T12MP-12 for 12 volt operation, or
   T24MP-12 for 24 volt operation, as ordered.
3. Antenna connector, COMM Transceiver. *narco* Part No. 41130-1.
4. Antenna connector, NAV. Receiver. *narco* Part No. 41237-1, Plug; with 41237-2 Ferrule.
5. Mounting base-plate, for T12MP-12 or T24MP-12, *narco* Part No. 52085-101.

2-C. ACCESSORIES REQUIRED, but Not Supplied.

1. Cable, Modulator-Power and Accessory.
   a. 8 feet long, *narco* Part No. 90618-96.
   b. 16 feet long, *narco* Part No. 90618-192.
2. COMMUNICATIONS ANTENNA: *narco* VP-10, VTP-17, or equivalent.
3. NAVIGATION ANTENNA: *narco* VRP-15A, VRP-37, or equivalent.
4. COMMUNICATION ANTENNA CABLE, see Section J,1., below.
5. NAVIGATION Antenna Cable, see Section J,2. below.
6. Glide Slope Switching Cable, (If a Glide Slope receiver is to be controlled by the switching provided in the Mark 12 Equipment), see 2-D,2., below.
7. Headphones: Low impedance type, 300 to 1000 ohms, or Loud Speaker, Voice coil impedance, 3 to 6 ohms nominal. Both headphones and speaker may be used if desired.
8. Microphone: Low impedance carbon type. The quality of transmission depends to a considerable extent on the quality of the microphone used. A noise cancelling type is very helpful and is recommended.

2-D. OPTIONAL UNITS and ACCESSORIES AVAILABLE.

2-D,1. Cables and Connectors.

a. Glide Slope Switching Cable and Connector Kit. *narco* Part No. EL-2053.

b. Connector Kit, for Modulator-Power and Accessory Cable, *narco* Part No. EL-2052.

2-D,2. Omni Converters.

a. ***narco*** VOA-4. Omni Converter. For VOR or LOCALIZER Course Deviation.

b. ***narco*** VOA-5. Omni Converter, with Glide Slope Indicator. For VOR, LOCALIZER and Glide Slope Deviation.

c. ***narco*** VOA-6. Omni Converter. For VOR Course Deviation.

2-D,3. Quartz Crystals.

a. Crystal Kit, for conversion of Mark-12 Transceiver from 90 to 360 Communication Channels. ***narco*** Part No. EL-2051.

2-E. MECHANICAL INSTALLATION.

2-E,1. Panel Unit.

In mounting the ***narco*** Mark 12 Panel Unit the case is installed first, using mounting brackets on the sides and a grounding and supporting strap attached to the rear of the case. These supports must be fabricated by the installer. See Figure 9, page 34.

a. Rear-Mounted Case (recommended).

Install the grounding and supporting strap from the rear stud of the case to a structural member of the airframe. Allow sufficient space behind the case for cables and access to the "Airloc" fastener. Remove all paint and other finishes from the airframe, to make a good electrical ground where the supporting strap is attached.

b. Front Panel Mounting.

Where there is an existing cutout or where space limitations will not permit rear case-mounting, the case may be mounted from the front of the Instrument Panel. However, the cutout required to provide clearance for the mounting bracket bosses on the case will not be completely covered by the Mark 12 Trim Panel when the unit is inserted in the case.

Install a grounding and supporting strap from the rear stud of the case to a structural member of the airframe. Allow sufficient space behind the case for cables and access to the connectors.

c. Side Ground and Support Straps.

Provision has also been made for fastening ground and support straps on either side of the case near the rear. This may be found convenient in some installations, especially where other equipments are involved. For details see Figure 9, page 34.

2-E,2. Modulator-Power Unit.

A Mounting Base is provided to be permanently installed in the aircraft. The Modulator-Power unit is attached to this base in a manner which permits easy removal and inspection or servicing. See Figure 10, page 34 for details.

The Mounting Base and in turn the Modulator-Power Unit must have a good electrical ground, similar to the Panel Unit. See 2-E,1, above.

2-F. ELECTRICAL CONNECTIONS.

The ***narco*** Mark 12 Equipment consists primarily of a Panel Unit which becomes the central point for the electrical connections to the Modulator-Power Unit and to all other accessories. All connections are associated with the rear of the Panel Unit chassis. The rear of the chassis is readily accessible because the rear of the outside case is open, except for a narrow vertical strap which holds the ground-support stud and "Airloc" fastener.

All connections except the two separate antennas (Communication and Navigation) are made via two connectors attached to a short cable having two branches, extending from the rear of the Panel Unit chassis.

2-F,1. Modulator-Power and Accessory Cable.

The Panel Unit Cable branch having the large 16-circuit connector P-101 is to be connected to J-501, on the Modulator-Power (MP) Unit. Figure 5, page 31 gives the circuits between the mating connectors P-102 and P-501, corresponding with the Panel Unit Connector P-101 and the MP Unit Connector J-501 respectively.

The Cable Assemblies made by ***narco*** (See above 2-B,3., 2-D,2,a.) have in addition to the connections to the MP connector P-501, a five wire six foot cable for the usual microphone, headphone and loudspeaker connections. Also extending from the opening in the P-102 Cable Connector Shell are three wires about 16 inches long for the following purposes:

a. RED #16 for the Primary + DC input of either a nominal 12 or 24 volts.

b. WHITE #22 for connection of the Front Panel Lamps to an external dimmer circuit.

c. BLUE and WHITE #22 for the connection of the audio output from other equipment to the Audio Amplifier input of the Mark 12 Equipment.

NOTE: Any audio output from other equipment tied to this wire must include an appropriate series coupling capacitor, because none is incorporated in the unit.

2-F,2. Navigation Cable.

The Panel Unit Cable branch having the small 6 circuit connector P-301 is provided for connection via a mating connector to an Omni Converter Unit such as the ***narco*** VOA-4, VOA-5, or VOA-6. Connections for such units are given in the Table below and in the information supplied with the various Omni Converter Units.

If a ***narco*** VOA-6 Omni Converter is mounted near enough to a MK-12 Equipment, it may be possible to connect the P-301 connector on the MK-12 cable directly to the compatible mating connector on the VOA-6 Equipment.

For Connections, see Table V, page 30.

2-F,3. Glide Slope Channel Selector Cable.

The Navigation Receiver Channel Selector is provided with switch sections for simultaneous and automatic Glide Slope Receiver Channel Selection.

In order to use this switching when a Glide Slope Receiver such as the ***narco*** UGR-1A is provided, it is necessary to make connections directly to certain switch sections in the Mark 12 Navigation Receiver Channel Selector Assembly. A hole has been provided in the rear of the Panel Unit chassis near the bottom on the Navigation Receiver side to accommodate the necessary cable. Information on the location of the switch sections and the required connections is given in the instructions accompanying the Glide Slope Channel Selector Cable and Connector Kit. (See 2-D,2,b., above).

2-G. PRIMARY POWER.

2-G,1. Power Source.

The primary power source may be either a nominal 12 or 24 volts, depending on the connections in the Panel Unit and whether a T12MP-12 or T24MP-12 Modulator Power Unit is used.

2-G,2. Circuit and Equipment Protection.

The primary DC circuit to the equipment should be protected with a fuse or other protective device rated as follows:

15.0 amps for a nominal 12 volt installation.

7.5 amps for a nominal 24 volt installation.

2-G,3. Voltage Conversion.

a. The Modulator Power Units are made for either a nominal 12 or 24 volt operation and are not convertible from one voltage to the other.

b. The Panel Unit is made so that it can be operated as a nominal 12 or 24 volt installation, depending on a few simple connection changes on a terminal strip near the top front of the chassis and a change in the connections to the Panel Lamps.

2-G,4. Panel Unit Voltage Conversion.

a. Nominal 12 to 24 Volt Conversion.

1. Looking at the front of the chassis from above, observe the 8 terminal strip parallel with the Front Panel, located just below the volume controls. Consider the terminals numbered 8, 7, 6, 5, 4, 3, 2, 1, reading from *left* to *right*.
2. Remove two wire jumpers, one from between terminals 7 and 6, and the other from between terminals 5 and 4.
3. Connect a single wire jumper between the terminals 6 and 5.
4. Again, looking at the front of the chassis from above, observe that the right hand Panel Lamp Socket has one terminal grounded on its mounting bracket. The other terminal is connected to the left hand Panel Lamp Socket by one wire and to a source of primary DC Power by a second wire.
5. Remove the ground connection from the right hand Panel Lamp.
6. Move the wire coming from the primary DC source to the terminal which had been grounded.

The two 12-volt Panel Lamps are now connected in series across the 24 volt DC supply.

b. Nominal 24 Volt to 12 Volt Conversion.

The procedure is essentially the reverse of a. above. For convenience, it is listed here in steps.

1. Looking at the front of the chassis from above, observe the 8 terminal strip parallel with the Front Panel, located just below the volume controls. Consider the terminals numbered 8, 7, 6, 5, 4, 3, 2, 1, reading from *left* to *right*.
2. Remove the single jumper wire between the terminals 6 and 5.
3. Connect two wire jumpers, one between terminals 7 and 6 and the other between terminals 5 and 4.
4. Again, looking at the front of the chassis from above, observe that the right hand Panel Lamp Socket has one terminal connected by a wire to the left hand Panel Lamp Socket and the other terminal connected to a source of primary DC power.
5. Move the wire from the DC source to the same terminal with the wire going to the left hand Panel Lamp Socket.
6. Connect the now empty right hand Panel Lamp Socket terminal to ground by means of a short wire jumper to the Lamp Socket Mounting Bracket.

The two 12 volt Panel Lamps are now connected in parallel across the 12 volt DC supply.

2-H. ANTENNA REQUIREMENTS.

2-H,1. Communications.

Satisfactory reception and transmission calls for the use of an antenna having a nominal impedance of 50 ohms and a low Voltage Standing Wave Ratio (VSWR) over the frequency range to be used.

The 360 channel version of the ***narco*** Mark 12 Transceiver has an operating frequency range of 118 to 136 megacycles. The ***narco*** VP-10 Communication Antenna has been designed for this frequency range and is recommended for this service.

If the 90 channel version of the ***narco*** Mark 12 Equipment is to be used, the frequency range is 118 to 127 megacycles and the ***narco*** VTP-17 rod antenna may be used. This antenna will also function with the 360 channel equipment but the performance may be somewhat impaired at certain frequencies.

Also, if a 90 channel equipment is to be installed initially, with the objective of conversion to 360 channels at a later date, it may be advisable to install a ***narco*** VP-10 antenna initially.

Only one antenna is necessary for communications, since the antenna changeover switching is built into the unit.

The ***narco*** VP-10 Communication Antenna or the ***narco*** VTP-17 bent whip antenna should be mounted on as large and flat a metallic surface as is possible. Such a mounting surface is often found directly in front of the windshield in fabric covered ships or at the center of the cabin roof in metal ships. Where no such surface exists a suitable ground plane may be provided by cementing metallic foil on the inside surface of the non-metallic structure.

Do not lengthen or shorten the VTP-17 rod antenna, as it has been cut to proper length for most efficient radiation at the frequencies used.

The antenna should be located at least 12″ from other objects on the surface of the aircraft.

2-H,2. Navigation.

In any VHF radio installation, the type of antenna and its location is extremely important. Only with the proper antenna in the best location can the full range and accuracy of the VHF Omni Range system be realized. In installations where an Omni converter is to be used with the ***narco*** Mark 12 navigation receiver, **a horizontally polarized antenna is absolutely necessary.**

The quarter-wave whip, normally used for communications, is definitely not satisfactory, although it may appear to be when tried. While vertically polarized components of the omni signal are not normally radiated by the ground station, they are frequently produced by reflections. Therefore, a vertical antenna may receive strong signals not coming directly from the ground, giving very unreliable bearing information.

Location of the antenna is of primary importance. The antenna should be located well away from the engine(s) and propeller(s). Good reception is usually afforded by placing the antenna on top of the aircraft behind the cockpit or at the top of the vertical stabilizer. Other antennas and wires, located within two feet of the omni antenna may cause weak reception from some directions and should be avoided.

If the Navigation Receiver in the ***narco*** Mark 12 Equipment is to be used for communication only, it may be connected to any communication type antenna which is not being used for transmission.

Either the ***narco*** VRP-15A *mast-type* or the ***narco*** VRP-37 fin-mounting Navigation Antenna may be used with the ***narco*** Mark 12 Navigation Receiver and an Omni Converter.

The RF cable should be RG-58A/U of as short a length as is practical. All bends should have at least a 6″ radius.

If another navigation receiver is to be operated from the same antenna as the MARK 12, the following precautions should be taken. The electrical length of the RF Cable from the MARK 12 Unit to the interconnecting "T" should be 22⅝″ long, plus any multiples of 35″ necessary for installation. To determine the length of the cable necessary for any other Narco Equipment connecting to this "T", consult the appropriate instruction book.

2-J. POST-INSTALLATION CHECK-OUT.

After the installation has been completed, it should be operated on the ground, with all normal power turned on and the engine(s) running. The receivers should be checked for proper operation by channeling to available signals. A ground check of the transmitter should be made to determine output and audio quality. This may be done contacting the Control Tower.

CAUTION

When making tests on the COMM Receiver with a Signal Generator connected to the COMM. Antenna Connector, do not close the microphone switch or activate the transmitter in any way. This is to protect the Signal Generator from transmitter output power.

SECTION 3
OPERATION

3-A. INTRODUCTION.

The information concerning the operation of the ***narco*** Mark 12 Equipment contained in this manual is primarily functional, for the purpose of providing proper maintenance.

Complete control of the operation of the ***narco*** Mark-12 Equipment is confined to a few direct manual controls on the front of the Panel Unit.

3-A,1. Panel Unit Controls.

The controls consist of two Channel Selectors, two volume controls and an ON-OFF Primary DC Power Switch on the COM volume control. All references in the paragraphs below are as viewed looking at the front panel.

a. Communication Transceiver.

The Communication (COM) Transmitter and Receiver are combined in the left side of the Panel Unit Assembly and both are controlled by the left hand pair of Channel Selector Knobs.

The large outer knob operates the whole megacyle (Mc) channel selector switch sections near the left front and center of the chassis assembly. The selected whole Mc frequency appears in the upper row of numerals on the Selector.

The central COM knob operates the fractional megacycle (Mc) switch sections near the left rear of the chassis assembly. The selected fractional Mc frequency appears in the lower row of numerals on the selector.

The small knob near the top, to the left of the center operates the COM Receiver Volume Control and near its maximum counter-clockwise position operates the primary DC Power ON-OFF Switch for both the Transceiver and the Navigation Receiver.

b. Navigation Receiver.

The Navigation (NAV) Receiver Channel Selector on the right hand side operates the channel selector switches and indicates the selected channel in the same manner as the COM Selector described under **a.,** above.

In addition to selecting the NAV Receiver Channel the NAV Channel Selector is provided with switch sections for automatically selecting the corresponding GLIDE SLOPE CHANNEL, when a Glide Slope Receiver such as the ***narco*** UGR-1A Equipment is installed.

The NAV Receiver volume is controlled by the small knob near the top, to the right of the center.

3-A,2. Operating Procedures.

Information concerning operation procedures is provided in the Operators Manual which is shipped with each Equipment.

Also, much information on operating practice is provided in the current issues of the FAA Flight Information Manual, the FAA Airmans Guide, the various Local, Sectional and WAC Charts, Radio Facility Charts, etc.

SECTION 4
CIRCUIT DESCRIPTION

4-A. INTRODUCTION.

The ***narco*** Mark 12 Equipment is contained in a Panel Unit intended for aircraft instrument panel mounting and a Modulator-Power Unit which may be mounted in a remote location. The two units are interconnected by a cable which may be as much as 16 feet long.

4-A,1. Panel Unit.

The Panel Unit contains two major items, a Communications Transceiver and a Navigation Receiver. The Transceiver consists of a VHF Transmitter and Receiver, operated by a single control, to provide "simplex" communication on either 90 or 360 crystal controlled channels. The Navigation Receiver has 100 channels for OMNI Navigation and ILS Localizer service. Separate connectors are provided for Communication and Navigation Antennas.

The Panel Unit may be operated on a nominal DC Supply Voltage of either 12 or 24 volts, depending on a few simple connection changes on a terminal strip.

4-A,2. Modulator-Power Unit.

The Modulator-Power Unit contains an Audio Amplifier/Modulator and a DC to DC Converter. The Audio Amplifier serves as the transmitter modulator in the transmit condition and operates the headphones and loudspeaker in the receive condition. The DC to DC Converter changes the primary DC supply to the DC voltages required by the various circuits.

The Modulator-Power Units are not convertible from one primary DC voltage to another. There are two types available. The Type T12MP-12 is to be used on a nominal 12 volt DC supply and the Type T24MP-12 is to be used on a nominal 24 volt DC supply.

4-B. COMMUNICATIONS TRANSMITTER.

There is a maximum of 360 (380 in the export version) crystal controlled transmitter channels provided by the Mark-12, using the difference frequency between the second harmonic of the high frequency oscillator, V-205, and the fundamental frequency of the low frequency oscillator, V-103B.

The high frequency oscillator (HFO), V-205, is a crystal stabilized, modified Colpitts oscillator employing a 7587 nuvistor vacuum tube. It uses fifth overtone crystals and operates on the fundamental oscillator frequencies 63.7375 Mc to 72.2375 Mc (63.2375 Mc to 72.2375 Mc in the export version) in 0.5 megacycle steps.

The low frequency oscillator (LFO), V-103B, is an untuned, crystal controlled Colpitts oscillator employing the triode section of a 6EA8 vacuum tube. It operates in the frequency range of 8.525 Mc to 9.475 Mc in 50 or 100 kilocycle steps.

Second harmonic HFO energy is applied to the control grid of V-204, which is a balanced mixer used to supress second harmonic energy of the HFO in the transmitter output circuits.

Fundamental energy of the LFO is applied to one of the deflection plates of V-204 through C-266. The difference frequency, selected by the plate circuit of V-204, is applied to the control grid of the first amplifier, V-203. The tube, V-203, amplifies this signal and applies it to the control grid of the second amplifier, V-202, where it is further amplified and applied to the final amplifier, V-201.

The final amplifier is a 7551 beam power amplifier. It delivers approximately 8 watts of RF carrier power through a "T" filter to the antenna. CR-101 is used as a T-R relay and is biased so that it blocks energy into the receiver tuned circuit during transmit time.

High level plate modulation is applied to the final amplifier by the T( )MP-12 transistorized modulator-power unit.

4-C. COMMUNICATIONS RECEIVER.

A crystal controlled, double conversion superheterodyne circuit is employed in the communications receiver of the Mark-12. The desired RF signal enters the receiver at the communications transceiver antenna connector, J-101. The signal is applied through CR-101, which has its bias controlled so that it serves as a T-R relay, to the first of three RF tuned circuits. These circuits are tuned in steps of one megacycle by the use of gang tuned variable inductors. The RF signal is amplified by V-101(6BH6) and applied through a capacitively coupled double tuned circuit to the control grid of the first mixer, V-102.

The high frequency oscillator (HFO), V-205, is a crystal stabilized, modified Colpitts oscillator. Its fundamental frequency range, using fifth overtone crystals, is 63.7375 Mc to 72.2375 Mc (63.2375 Mc to 72.2375 Mc in export version) in 0.5 Mc steps. The plate circuit is tuned to the second harmonic of the oscillator, and second harmonic energy is injected through C-233 and C-113 to the control grid of the first mixer V-102.

The high frequency IF (first IF) is produced by selecting the difference frequency between the incoming RF signal and the HFO injection energy. This difference frequency selection is accomplished by a tuned circuit containing T-101 and T-102. The tuning of T-101 and T102 is done in 50 kilocycle steps by gang switched step inductors. The HF IF is tuned over the range of 8.525 Mc to 9.475 Mc. The output of the HF IF is applied to the control grid of the second mixer V-103A.

The low frequency oscillator (LFO), V-106, is an untuned crystal controlled Colpitts oscillator operating in the frequency range of 8.525 Mc to 9.475 Mc in 50 or 100 kilocycle steps. The output of this oscillator is injected to the screen grid of the second mixer, V-103, through C-123.

The low frequency IF (second IF) is produced by selecting the difference frequency between the high frequency IF output and the LFO injection energy. This selection is done by T-103, which is the first of three 0.5 Mc IF transformers. T-103, T-104, and T-105 are overcoupled to give an adequate bandwidth. The signal from T-103 is applied to the control grid of V-104. It is amplified by V-104, applied through T-104 to V-105 where it is again amplified. It is then applied through T-105 to CR-102, which is a silicon diode detector. The output of the peak limiting noise limiter, CR-103, is the input to the audio volume control, R-122. The output of the audio volume control is applied through R-319 and C-348 to the control grid of the cathode follower V-305B.

AVC is developed by detector current flow across R-118, R-121 and R-123. AVC is applied to the RF and IF stages with the exception of the last IF amplifier V-105.

4-D. NAVIGATION RECEIVER.

A double conversion superheterodyne circuit is employed in the navigation receiver of the Mark-12. The desired signal enters the receiver at the navigation receiver antenna connector, J-301. The signal is applied to the first of three tuned RF circuits. These circuits are tuned in steps of one megacycle by the use of gang tuned variable inductors. The RF signal is amplified by V-301 (6BH6) and applied through a capacitively coupled, double tuned circuit to the control grid of the first mixer, V-302.

The high frequency oscillator (HFO), V-305A, is a crystal stabilized grounded grid oscillator. Its frequency range, using fifth overtone crystals, is 96.55 Mc to 104.55 Mc in one megacycle steps. Fundamental oscillator energy is injected through C-310 to the control grid of the second mixer, V-302.

The high frequency IF (first IF) is produced by selecting the difference frequency between the incoming RF signal and the HFO injection energy. This difference frequency selection is accomplished by a tuned circuit containing T-301. The tuning of T-301 is done in 100 kilocycle steps by gang switched step inductors. The HF IF is tuned over the range of 11.45 Mc to 12.35 Mc. The output of the HF IF is applied to the control grid of the second mixer, V-303.

The low frequency oscillator (LFO) is a Colpitts oscillator operating in the range from 10.025 Mc to 10.925 Mc. It is inductively tuned, by the step inductor L-315, in 100 kilocycle steps. The output of this oscillator is injected to the control grid of the second mixer, V-303, through C-316 and the secondary circuit of T-301.

The low frequency IF (second IF) is produced by selecting the difference frequency between the output of the HF IF and the LFO injection energy. This selection is done by T-302, which is the first of two 1.425 Mc IF transformers. T-302 and T-303 are overcoupled to give an adequate bandwidth. The signal from T-302 is applied to the control grid of V-304. It is amplified by V-304 and passed through T-303 to CR-301, which is a silicon diode detector.

The omni output is applied from the diode load directly to the omni converter input. The peak limiting noise limiter, CR-303, is a silicon diode. The output of the noise limiter is the input to the audio volume control, R-318. The output of the audio volume control is applied through R-320 and C-347 to the control grid of the cathode follower V-305B.

The delayed AVC is developed by detector current flow through R-317, R-333, and R-316 and is applied to the RF and IF stages with the exception of the last IF stage, V-304. The time constant of the AVC is very slow to provide accurate omni range bearings.

4-E. MODULATOR-POWER UNIT.

The power supply section of the T( )MP12 uses two power transistors, Q-501 and Q-502, and a power transformer, T-501, in a circuit whose simplified operation is as follows. The instant primary voltage is applied (A+), because of the inevitable dissimilarity of the two transistors, more current will flow in one than in the other. This greater flow of current through one half of the primary winding of the power transformer induces a bias on the transistors such that the conducting unit is driven into greater conduction and the other is held at cut-off.

Almost instantly the transformer reaches saturation. Thus having reached maximum flux density, there is no more induced voltage in the bias windings which are connected to the transistor circuitry. Therefore, the current through the conducting transistor decreases, and bias voltage at opposite polarity is developed which cuts off this transistor and simultaneously causes the second transistor to conduct. The above procedure repeats with the second transistor. This switching action repeats at high speed and the resultant output voltage of T-501 is essentially a square wave.

A full wave bridge rectifier consisting of CR-501, CR-502, CR-503, and CR-504 in conjunction with the center tapped secondary of T-501 provides a simple means of obtaining a dual voltage output. Filtering of these DC voltages is easily accomplished because of the high frequency of the power supply.

The audio section of the T( )MP12 is also transistorized. It contains Q-401, Q-402, Q-403, T-401, T-402 and their associated components. This section serves two functions. In transmit, Q-401 performs the function of microphone amplifier. It drives Q-402 and Q-403, through T-401, to perform the function of transmitter modulator. Modulation is accomplished by transformer action in T-402 since final current flows through one secondary winding of T-402.

In receive operation, Q-401 performs the function of an audio amplifier and is driven by the cathode follower V-305B. The output of Q-401 is transformer coupled, through T-401, to Q-402 and Q-403, which perform the function of audio output amplifiers. The output of the audio amplifiers is transformer coupled, by T-402, to a speaker, and/or capacity coupled through C-404 to headphones.

SECTION 5
MAINTENANCE

5-A. INTRODUCTION.

The ***narco*** Mark 12 Equipment consists primarily of an aircraft instrument Panel Unit, having direct manual controls and a remote mounted modulator-power unit. All interconnections are normally made at or near the rear of the Panel Unit. There are separate single circuit connectors for the Communication and Navigation Antennas on the rear panel.

There are two kinds of Panel Unit chassis in service. They are type CN-89 and CNP-89. They differ mostly in the way in which connections, other than antennas, are made at the rear of the panel unit. There is also some difference in the gain or signal level in the Communication receiver.

5-A,1. Panel Unit Chassis Type CN89 Connections.

The Type CN89 Panel Unit Chassis has a short cable with two branches extending from the rear. The smaller branch has a 6 circuit connector which may connect directly or via an extension cable to a ***narco*** VOA-6 OMNI Converter, or via an adaptor cable to a ***narco*** VOA-4, VOA-5, or other Navigation Converter. The larger branch has a 16 circuit connector to accommodate the connector and cable for the Modulator-Power Unit and the connections to the primary DC Power and accessories.
If a Glide Slope Receiver such as the ***narco*** UGR-1A is being controlled by the channel selector of the Navigation receiver, there will be an additional cable extending from the rear of the Panel Unit.

For details of these interconnections see Figures 7 and 8, pages 32 and 33.

5-A,2. Panel Unit Chassis Type CNP89 Connections.

The Type CNP89 Panel Unit Chassis has all connectors mounted directly on the rear of the chassis, instead of being attached to short cables extending from the chassis.

The 16 circuit connector on the chassis provides the same circuits and functions as the 16 circuit connector on the CN89 cable. Connections to the Modulator-Power Unit, +DC Supply, Accessories, etc., are all the same. See Figures 4 and 5, page 31.

5-B. MECHANICAL MAINTENANCE.

5-B,1. Panel Unit Access.

The Panel Unit Case is normally installed permanently in the aircraft. To remove the unit, it is only necessary to disconnect the cables at the rear of the chassis and release a single "Airloc" fastener. The unit may then be withdrawn from the front of the case.

The open frame chassis design is such that practically every component, except the ones in the three small shielding compartments, is readily accessible as soon as the unit is withdrawn from the case. Disassembly and re-assembly of the COM and NAV Channel Selectors is somewhat involved, but detailed instructions for the procedure are given in paragraphs 5-B,4 through 5-B,12 below.

The components in the three small shielding compartments are made accessible by removing the covers, which are held in place by small screws. The two compartments near the center of the chassis have both top and bottom covers.

A certain sequence of replacing the covers of the center compartments is helpful. The bottom cover on the left center (COMM side) may be removed and replaced without disturbing top cover. However, if the top cover is removed, it will be easier to remove the bottom cover before reassembly of the top cover. Once the top cover is in place, the bottom cover may be re-assembled without difficulty.

NOTE: The bottom cover fits *inside* the top cover.

The top cover on the right center compartment (NAV. Side) may be removed and replaced without disturbing the bottom cover. However, if the bottom cover is removed, it will be easier to first remove the top cover before reassembly of the bottom cover.

The remaining compartment at the bottom left front (COM side) has only one cover. It is held in place by one screw at the rear flange of the cover and two tabs on the front flange of the cover. The tabs fit into slots at the front of the compartment proper.

5-B,2. Modulator-Power Unit Access.

The Modulator Power Unit is usually installed in a remote location on a Mounting Base. The Mounting Base is normally installed permanently. To remove the Unit, it is only necessary to loosen (without removing) four mounting screws and detach the single cable connector. Access to all components is then made by removing the screws holding the two "L" shaped pieces covering the four sides.

If the Transistor Q-401 (First Audio Amp.) is removed, care must be exercised to prevent damaging the insulator under the mounting, and to replace it properly.

5-B,3. Periodic Service.

The only item which may require occasional attention is the COM Fractional Mc Channel Selector Detent Assembly, near the rear of the chassis. It consists of a star wheel, roller, and detent fulcrum, which should be lubricated with wide temperature range grease. It is recommended that this assembly be checked whenever the Unit is removed for electrical maintenance.

5-B,4. Channel Selector Knob, Dial and Shaft Removal, Replacement and Positioning.

The procedures for disassembly and re-assembly of the Channel selectors given in the succeeding paragraphs 5-B,5., through 5-B,9., give a procedure which should maintain the proper relations among the Knobs, Dials, Shafts, and Switch Section Rotors and Stators. If these relations become mis-arranged for any reason the correct relations may be re-established according to the sub-section 5-B,10., below.

NOTE: In the succeeding sub-sections through 5-B,12., all references to mechanical position such as top and bottom, left and right, front and rear are as viewed facing the front of the Panel Unit in an upright position.

5-B,5. COM Fractional Mc Shaft, Removal and Replacement.

Removal Procedure:

a. Remove detent spring and roller which engages the star wheel assembly at the left side rear of the set on the COM. Fractional Mc Shaft and then loosen the two set screws in the star wheel assembly.

b. Rotate the COM. Mc Knob to the 118 position, the COM. Fractional Mc Dial to the 0.3 position, and the NAV. Mc Knob to the 108 position and the NAV. Fractional Mc Dial to the 0.6 position.

CAUTION: If the knobs and dials are not set as indicated, the switch sections may be damaged, when the shafts are removed as described under step g. below.

c. Loosen set screws and remove from the Unit both Volume Knobs, COM. Fractional Mc Knob and the NAV. Fractional Mc Knob.

d. Loosen set screws in the following parts. COM. Mc Knob, NAV. Mc Knob, COM. Fractional Mc Dial, and NAV. Fractional Mc Dial.

e. Loosen and remove the four screws at the corners of the Trim Panel. The Panel can now be removed by pulling it forward from the Unit. Note COM. Mc Knob, COM. Fractional Mc Dial, NAV. Mc Knob and NAV. Fractional Mc Dial will come off with removal of Trim Panel as they are captivated in this assembly.

f. Front of chassis is now exposed. On the left hand side is the COM. Mc detent. Remove its screws, nuts, lockwashers, and the spacers which retain the detent assembly to the front of the chassis.

g. Note that it is necessary to remove the COM. Mc Shaft in order to remove the COM. Fractional Mc Shaft. Both COM. Mc Shaft and detent assembly and COM. Fractional Mc Shaft can now be withdrawn simultaneously from the front of the chassis.

Replacement Procedure: Follow the Removal Procedure in reverse.

5-B,6. COM Whole Mc Shaft and Detent Assembly, Removal and Replacement.

Removal Procedure:

Follow instructions described in Removal Procedure 5-B,5., above but omit step a. and step g. The COM Mc Shaft and Detent Assembly can now be withdrawn from the front of the chassis without disturbing the COM Fractional Mc Shaft and Detent.

Replacement Procedure:

Follow the Removal Procedure in reverse.

5-B,7. NAV Whole Mc Shaft and Detent Assembly, Removal and Replacement.

Removal Procedure:

a. See Removal Procedure 5-B,5., above and perform steps b., c., d., and e.

b. After the above steps have been completed, the front of the chassis will be exposed and on the right hand side will be the NAV Mc Shaft and Detent Assembly. This can then be removed by loosening and removing the two mounting nuts and lockwashers at the rear of the variable inductor and crystal switch section assembly.

c. In the same area remove the hairpin retainer from the NAV Mc Shaft.

d. On the front of the chassis the two long strut screws can now be removed, but be careful to note the location of the two metal spacers in the wafer assembly.

e. The NAV Mc Detent and Shaft Assembly can now be withdrawn from the front of the chassis.

Replacement Procedure:

Follow the Removal Procedure in reverse.

5-B,8. NAV. Fractional Mc Shaft, Removal and Replacement CN-89 Chassis Only.

Removal Procedure:

a. Position the NAV Fractional Mc Dial to 0.6. Then loosen the set screw which is seated the deepest in the NAV Fractional Mc Knob and remove the knob and its bushing from the Unit.

b. Loosen the two set screws in the hub of the NAV. Fractional Mc Dial.

c. At the rear of the L.F. Oscillator, glide slope, and variable inductor switch sections, there is a detent rotor assembly. Loosen the two set screws in the detent rotor assembly and also remove the hairpin retainer on the NAV Mc Shaft in front of the L.F. Oscillator Assembly.

d. Then from the front of the chassis, push in the NAV Fractional Mc Shaft flush with the front of the NAV Whole Mc Shaft. It will be seen by this operation that the NAV Fractional Mc Shaft will be protruding to the rear of the set, at the rear of the LF oscillator and switch section assembly. Continue to withdraw the shaft to the rear of the set.

e. In the rear panel there is a clearance hole provided to facilitate the removal of this shaft. Any wires interfering with this clearance hole should temporarily be carefully dressed aside.

Replacement Procedure:

Follow the Removal Procedure in reverse.

5-B,9. NAV. Fractional Mc Shaft Removal and Replacement. CNP-89 Chassis Only.

Removal Procedure:

Follow instructions described in Removal Procedure 5-B,8 above. In addition it will be necessary to remove the two screws on the rear panel of the chassis which support the plug and connector bracket. The clearance hole in this bracket should be held in line with the clearance hole in the rear panel to facilitate removal of the shaft.

Replacement Procedure:

Follow Removal Procedure in reverse.

5-B,10. Reference Positions for Channel Selector Dials, Shafts, and Switch Sections.

a. COM Fractional Megacycles.

For the 0.5 Fractional Mc position the ⅜" diameter metal shaft flats will be in a horizontal plane, with the key notch in the Switch Section Rotors at the top.

All of the Switch Section Stators have the letters "X" stamped on the front right side adjacent to the strut screw.

b. COM Whole Megacycles.

For the 118 Whole Mc position the ⅜" diameter glass epoxy shaft flats will be 18° clockwise from a vertical plane, with all the key notches in the Switch Section Rotors on the right side at 108° clockwise from the vertical.

The first seven Switch Section Stators have the upper right hand corner cut off. The remaining four, have the letter "X" stamped on the top front of the section.

c. NAV Whole Megacycles.

For the 108 Whole Mc position the flats on the ¼" diameter *brass* shaft shall be in the same plane as the mounting strut screws in the Crystal Switch Assembly. The key notch in the eight Switch Section Rotors is on the flat toward the bottom of the Unit.

The eight Switch Section Stators have a raised key moulded on the peripheral surface, which appears at the right of the top strut screw.

d. NAV Fractional Megacycles.

For the 0.6 Fractional Mc dial position the flats on the ¼" diameter *steel* shaft shall be in the same plane as the mounting strut screws in the L.F. Oscillator Assembly. The key notch of the rotor in the enclosed shielded switch section (top cover removed) is on the flat toward the top of the Unit. The key notch in the five switch section rotors behind the enclosed shielded switch section, is on the flat toward the bottom of the Unit.

The Switch Section Stator in the shielding compartment has a large cutout at the top. The remaining five stators have a raised key moulded on the peripheral surface, which appears at the right side below the upper strut screw.

5-B,11. COM Detent Spring Position, Fractional Mc, Ch. Sel. Switch.

When the detent star wheel assembly is installed for 10 position operation, the long end of the detent spring shall be located on the inside edge of the tab nearest the shaft.

When the detent star wheel assembly is installed for 20 position operation, the long end of the detent spring shall be located on the inside edge of the outermost tab from the shaft.

5-B,12. NAV Detent Position, Fractional Mc, Ch. Sel. Switch.

This detent position is not related to any particular fractional Mc position, but it must be seated when the rotor blade is centered on any stator contact. This centering may be observed on the switch section in the enclosed shielded compartment, when the top cover is removed.

5-C. ELECTRICAL MAINTENANCE.

5-C,1. Precautions.

a. Supply Voltage.

NOTE: In order that the conditions in the following alignment procedure may be met, the DC input voltage to the unit must be 13.75 VDC or 27.5 VDC, depending on input requirement of unit under test, when the transmitter is keyed.

b. Duty Cycle.

It must also be emphasized that a 20% duty cycle should be observed when aligning the transmitter—one minute on and four minutes off.

5-C,2. Equipment Required.

a. RF Power Wattmeter — Bird Termaline or equivalent.

b. VTVM —RCA Voltohmyst or equivalent.

c. AC VTVM — Ballentine Model 300D or equivalent.

d. Carbon Microphone.

e. Signal Generator — General Radio Model 1001A or equivalent.

f. Signal Generator — Hewlett Packard Model 608D or equivalent.

g. Audio Wattmeter — General Radio Type 583-A or equivalent.

h. High Impedance Dummy Detector — See Figure 1., page 30.

i. Frequency Counter—Hewlett Packard Model 524B or equivalent.

j. Frequency Meter — BC-221-D or equivalent.

k. RF Voltmeter — Hewlett Packard Model 410B or equivalent.

5-D. TRANSMITTER ALIGNMENT.

Reference: Schematic, Fig. 11, page 55.

5-D,1. Low Frequency Oscillator.

Procedure:

a. Connect a 50 ohm RF Power Wattmeter to J-101.

b. Connect a VTVM, through a one megohm resistor, to Pin 9, V-103B. Set the VTVM to indicate negative DC, 15 volt scale.

c. Key the transmitter and observe the VTVM indication for each of the fractional Mc selector positions. An indication of approximately –6 VDC should be observed.

d. Un-key the transmitter and remove the RF wattmeter from J-101. Remove the one megohm resistor and the VTVM from Pin 9, V-103B.

Normal Indication:

Approximately –6.0 VDC, measured through a one megohm resistor, on Pin 9, V-103B on all fractional Mc selector positions.

5-D,2. High Frequency Oscillator.

Procedure:

a. Connect a 50 ohm RF power wattmeter to J-101.

b. Connect a VTVM, through a one megohm resistor, to Pin 4, V-205. Set the VTVM to indicate positive DC, 15 volt scale. Key the transmitter.

c. Set the Mc selector to the 118 position. Adjust C-241 for minimum positive DC indicated on the VTVM.

d. Set the Mc selector to the 135 position (126 on the 90 channel version) and adjust L-218 for minimum positive DC indicated on the VTVM.

e. Repeat steps c. and d. until no further decrease in positive DC indication can be obtained.

f. Observe the VTVM indication for each of the Mc selector positions. The indication should be approximately +8 VDC. It is well to note that the non-oscillating potential is approximately +10 VDC.

g. Un-key the transmitter and remove the RF wattmeter from J-101. Remove the one megohm resistor and the VTVM from Pin 4, V-205.

Normal Indications:

Approximately +8.0 VDC, measured through a one megohm resistor, on Pin 4, V-205 on all Mc selector positions.

5-D,3 Doubler,High Frequency Oscillator.

Procedure:

a. Connect a 50 ohm RF power wattmeter to J-101.

b. Connect a VTVM, through a one megohm resistor, to Pin 6, V-204. Set the VTVM to indicate negative DC, 15 volt scale. Key the transmitter.

c. Set the fractional Mc selector to the 0.5 position. Set the Mc selector to the 118 position. Adjust C-237 for maximum indication on the VTVM.

d. Set the Mc selector to the 135 position (126 on the 90 channel version). Adjust L-215 for maximum indication on the VTVM.

e. Repeat steps c. and d. until no further increase in VTVM indication can be obtained. Observe the indication for each of the Mc selector positions. The indication should be approximately –3.5 VDC.

f. When the conditions described above have been achieved, the deflector drive voltage should be checked with an RF voltmeter. This voltage measured on Pin 2, V-204, should be approximately 8.5 volts RMS. A Hewlett Packard 410B is suitable for this measurement. This voltage is an indication of the RF output of the LF oscillator, which cannot be accurately measured before this time.

g. Un-key the transmitter and remove the RF wattmeter from J-101. Remove the one megohm resistor and VTVM from Pin 6, V-204.

Normal Indication:

Approximately –3.5 VDC measured on Pin 6, V-204.

5-D,4. Transmitter Amplifiers.

Procedure:

a. Connect a 50 ohm RF power wattmeter to J-101.

b. Connect a one megohm resistor to Pin 7, V-203. Connect a VTVM to the one megohm resistor. Set the VTVM to indicate negative DC, 1.5 volt scale. Key the transmitter.

c. Set the fractional Mc selector to the 0.5 position. Set the Mc selector to the 118 position. Adjust C-228 for maximum indication on the VTVM.

d. Set the Mc selector to the 135 position (126 on the 90 channel version). Adjust L-214 for maximum indication on the AC VTVM.

e. Repeat steps c. and d. until no further increase in VTVM indication can be obtained.

f. Set the VTVM to indicate negative DC, 15 volt scale. Connect it to the junction of C-219 and R-227. This measures the control grid voltage on V-202.

g. Set the Mc selector to the 118 position. Adjust C-221 for maximum indication on the VTVM.

h. Set the Mc Selector to the 135 position (126 on the 90 channel version). Adjust L-211 for maximum indication on the VTVM.

i. Repeat steps g. and h. until no further increase in VTVM indication can be obtained.

j. Set the VTVM to indicate negative DC, 150 volt scale, and connect it to the junction of C-209 and R-226. This measures the control grid voltage on the final amplifier V-201.

k. Set the Mc selector to the 118 position. Adjust C-213 for maximum indication on the VTVM.

l. Set the Mc selector to the 135 position (126 on the 90 channel version). Adjust L-207 for maximum indication on the VTVM.

m. Repeat steps k. and l. until no further increase in VTVM indication is obtained.

n. Set the Mc selector to the 118 position. Adjust C-204 for maximum power indicated on the RF wattmeter.

o. Set the Mc selector to the 135 position (126 on the 90 channel version). Adjust L-202, by changing the spacing between turns, for maximum power indicated on the RF wattmeter.

p. Repeat steps h. and o. until no further increase in RF power is obtained.

q. Set the Mc selector to the 118 position. Adjust C-237, C-228, C-221 and C-213 in that order for maximum indication on the VTVM. Adjust C-204 for maximum power indicated on the RF wattmeter.

r. Set the Mc selector to the 135 position (126 on the 90 channel version). Adjust L-215, L-214, L-211 and L-207 for maximum indication on the VTVM. Adjust L-202 for maximum power indicated on the RF wattmeter.

s. Repeat steps q. and r. until no further increase in drive voltage and RF power is obtained.

t. Un-key the transmitter. Remove the VTVM and the one megohm resistor on Pin 7, V-203 from the unit. Remove the RF wattmeter from J-101.

Normal Indications:

First Amplifier—Approximately –0.5 VDC measured, through a one megohm resistor, on Pin 7, V-203.

Second Amplifier—Approximately –8.0 VDC measured at the junction of C-219 and R-227.

Final Amplifier—Approximately –80.0 VDC measured at the junction of C-209 and R-226.

Final Output Tank—Approximately 8 watts of RF carrier power measured on a 50 ohm RF power wattmeter.

5-E. COMMUNICATIONS RECEIVER ALIGNMENT.

Reference: Schematic, Fig. 11, page 55.

5-E,1. High Frequency Oscillator.

Procedure:

The high frequency oscillator is to be tracked in transmit function. Refer to the transmitter alignment procedure for the high frequency oscillator alignment procedure.

Normal Indication:

+7 to +9 VDC from 118 Mc through 135 Mc.

5-E,2. Low Frequency Oscillator.

Procedure:

The low frequency oscillator drive is to be measured at the control grid of V-106 through a 1 megohm resistor. This oscillator is an untuned, crystal controlled Colpitts oscillator.

Normal Indication:

–3.5 to –6.0 VDC from 0.00 Mc through 0.95 Mc.

5-E,3. Low Frequency IF Amplifier.

Procedure:

a. Connect AC VTVM to the junction of CR-103 and R-122.

b. Remove all connections from Pin 2, V-103. Connect a 47 ohm resistor from Pin 2, V-103 to ground. Connect signal generator to Pin 2, V-103. Set the signal generator to 500 Kc, 400 cps 30% modulation. Increase the signal generator output for a usable indication on the AC VTVM.

c. Set the signal generator to 490 Kc and tune the primary and secondary tuning slugs of T-103, T-104, and T-105 for maximum indication on the AC VTVM.

d. Set the signal generator to 510 Kc and tune the primary and secondary tuning slugs of T-103, T-104, and T-105 for maximum indication on the AC VTVM.

e. Repeat steps c. and d. until no further increase in AC VTVM indication is obtained, and peak amplitudes are approximately equal with approximately 20 Kc peak separation. The hole depth between the two peaks should be approximately 2.5 db.

f. Figure 2, page 30, illustrates the low frequency IF response.

g. Remove the signal generator and the 47 ohm resistor from Pin 2, V-103, and reconnect the components previously removed. Remove AC VTVM from junction of CR-103 and R-122.

Normal Indication:

75 μv (380 μv for CNP-89) maximum input for 0.60 VAC noise limiter output.

5-E,4. Selectivity, LF IF Bandwidth.

Procedure:

a. Connect AC VTVM to the junction of CR-103 and R-122.

b. Remove all connections from Pin 2, V-103. Connect a 47 ohm resistor from Pin 2, V-103 to ground. Connect the signal generator to Pin 2, V-103. Set the signal generator to 500 Kc, 400 cps 30% modulation.

Adjust signal generator output level to produce a usable indication on AV VTVM.

c. Vary the signal generator frequency across LF IF response. It will be noted that the response peaks approximately 10 Kc either side of 500 Kc, with 500 Kc falling at the bottom of a "hole" or "dip" in the response between the two peaks. See Figure 2, page 30, for low frequency IF response. Use the AC VTVM indication at this "hole" in the response, at 500 Kc, as the reference level to measure bandwidth.

d. With the reference level set, increase the generator output 6 db (2:1). Tune the signal generator frequency below 500 Kc until the reference level is obtained on the AC VTVM. Note this frequency. Tune the signal generator frequency above 500 Kc until the reference level is obtained on the AC VTVM. Note this frequency. The difference between the two noted frequencies is the total 6 db bandwidth.

e. With the reference level set, increase the signal generator output 60 db (1000:1). Tune the signal generator frequency below 500 Kc until the reference level is obtained on the AC VTVM. Note this frequency. Tune the signal generator frequency above 500 Kc until the reference level is obtained on the AC VTVM. Note this frequency. The difference between the two frequencies is the total 60 db bandwidth.

f. Remove the signal generator and the 47 ohm resistor from Pin 2, V-103 and reconnect the components previously removed. Remove the AC VTVM from junction of CR-103 and R-122.

Normal Indication:

6DB—32 Kc minimum total bandwidth.

60DB—95 Kc maximum total bandwidth.

5-E,5. LFO Conversion Gain.

Procedure:

a. Connect AC VTVM to the junction of CR-103 and R-122.

b. Remove all connections from Pin 2, V-103. Connect a 47 ohm resistor from Pin 2, V-103 to ground. Connect the signal generator to Pin 2, V-103 and set it to 10 Mc range, 400 cps 30% modulation.

c. Set the fractional Mc selector to the .00 position. Tune the signal generator to 9.475 Mc. Note indication on AC VTVM. Set the fractional Mc selector to the 0.50 position. Tune the signal generator to 8.975 Mc. Note indication on AC VTVM. Set the fractional Mc selector to the 0.90 position. Tune the signal generator to 8.575 Mc. Note indication on AC VTVM.

d. Remove the signal generator and the 47 ohm resistor from Pin 2, V-103 and reconnect all components previously removed from Pin 2, V-103. Remove the AC VTVM from the junction of CR-103 and R-122.

Normal Indication:

15 Kμv (100 Kμv for CNP-89) maximum input for 0.6 VAC noise limiter output.

5-E,6. HF IF Amplifier.

Procedure:

a. Connect AC VTVM to the junction of CR-103 and R-122.

b. Remove all connections from Pin 1, V-102. Connect a 47 ohm resistor from Pin 1, V-102 to ground. Connect signal generator to Pin 1, V-102. Set signal generator to 10 Mc range. 400 cps 30% modulation.

c. Set the fractional Mc selector to the 0.00 position. Set the signal generator to 9.475 Mc. Increase the signal generator output to obtain a usable indication on the AC VTVM. Tune the primary and secondary tuning slugs of T-101 and T-102 for maximum indication on the AC VTVM.

d. Set the fractional Mc selector to the .90 position. Set the signal generator to 8.575 Mc. Tune C-117, C-118, and C-122 for maximum indication on the AC VTVM.

e. Repeat steps c. and d. until no further increase of AC VTVM indication is obtained.

f. Check all fractional Mc positions for normal indication.

g. Remove the signal generator and the 47 ohm resistor from Pin 1, V-102, and reconnect the components previously removed. Remove the AC VTVM from the junction of CR-103 and R-122.

Normal Indication:

25 μv (180 μv for CNP-89) maximum for 0.6 VAC noise limiter output.

5-E,7. RF Amplifier.

Procedure:

a. Connect AC VTVM to the junction of CR-103 and R-122.

b. Connect signal generator to J-101.

c. Set the signal generator to the 118 - 136 Mc range, 1000 cps 30% modulation.

CAUTION—Do not key the transmitter. To do so may damage the signal generator.

d. Set the fractional Mc selector to the 0.50 position. Set the Mc selector to the 118 position. Set the signal generator to 118.50 Mc and set its output for a usable indication of the AC VTVM. Adjust C-104, C-109, and C-112 for maximum indication on the AC VTVM.

e. Set the Mc selector to the 135 position (126 for the 90 channel version). Set the signal generator to 135.50 Mc (126.50 for the 90 channel version). Adjust L-102, L-104, and L-106 for maximum indication on AC VTVM.

f. Repeat steps d. and e. until no further increase in AC VTVM indication is obtained.

g. Remove the signal generator from J-101 and the AC VTVM from the junction of CR-103 and R-122.

Normal Indication:

5 μv (10 μv for CNP-89) maximum input for 0.6 VAC noise limiter output on all channels.

NOTE: The nominal inputs indicated above may vary widely among individual Panel Units, depending on the AVC threshold characteristic. Therefore, the nominal input figures should be considered representative only.

5-E,8. Sensitivity and Audio Output.

Procedure:

a. Connect the audio wattmeter to the speaker output.

b. Connect signal generator to J-101. Set the signal generator to the 118 Mc to 136 Mc range, 1000 cps 30% modulation.

CAUTION—Do not key the transmitter. To do so may damage the signal generator.

c. Set the fractional Mc selector to the 0.00 position. Set the Mc selector to the 118 position. Set the signal generator to 118.00 Mc. Note the input required to produce a 6 db difference between signal plus noise and noise.

d. Set the fractional Mc selector to the 0.50 position. Set the Mc selector to the 126 position. Set the signal generator to 126.50 Mc. Note the input required to produce a 6 db difference between signal plus noise and noise.

e. Set the fractional Mc selector to the 0.90 position. Set the Mc selector to the 135 position (126 for the 90 channel version). Set the signal generator to 135.90 Mc (126.90 Mc for the 90 channel version). Note the input required to produce a 6 db difference between signal plus noise and noise.

f. Remove the signal generator from J-101, and the audio wattmeter from the speaker output.

Normal Indication:

2 μv maximum input for 6 db signal plus noise to noise, at the speaker output.

5 μv maximum input for 3 (2 watts for CNP-89) watts at the speaker output.

5-E,9. Automatic Volume Control (AVC).

AVC is developed as soon as a signal is detected. To determine if the AVC threshold is occuring at its proper point, measure the DC potential at the junction of R-123 and CR-102. This potential, with no signal applied, should be 0.00 VDC $\pm$0.2 VDC.

In the event this potential is more positive than 0.2 VDC, shunt R-120 with a value of resistance, not less than 6.8K ohms, that adjusts the potential to its proper level.

In the event this potential is more negative than 0.2 VDC, shunt R-117 with a value of resistance, not less than 560K ohms, that adjusts the potential to its proper level.

The AVC characteristic is such that a change of signal input level from 10 uv to 10K uv should produce a maximum of 4 db increase in the audio output.

5-F. NAVIGATION RECEIVER ALIGNMENT.

Reference: Schematic Fig. 11, page 55.

5-F,1. Low Frequency IF Amplifier.

Procedure:

a. Connect AC VTVM to the junction of R-316, R-333, and C-330.

b. Remove all connections from Pin 1, V-303. Connect a 47 ohm resistor from Pin 1, V-303 to ground, and connect the signal generator to Pin 1, V-303. Set the signal generator to 1.425 Mc, 400 cps 30% modulation. Increase the signal generator output for a usable indication on the AC VTVM.

c. Set the signal generator to 1.415 Mc and tune the primary and secondary tuning slugs of T-302 and T-303 for maximum indication on the AC VTVM.

d. Set the signal generator to 1.435 Mc and tune the primary and secondary tuning slugs of T-302 and T-303 for maximum indication on the AC VTVM.

e. Repeat steps c. and d. until no further increase in AC VTVM indication is obtained and peak amplitudes are approximately equal with approximately 20 Kc peak separation. The hole depth between the two peaks should be approximately 1.0 db.

f. Figure 3, page 30, illustrates the low frequency IF response.

g. Remove the signal generator and the 47 ohm resistor from Pin 1, V-303, and reconnect the components previously removed. Remove the AC VTVM from the junction of R-316, R-333, and C-330.

Normal Indication:

350 μv maximum input for 1.9 VAC detector output.

5-F,2. Selectivity—Low Frequency IF Bandwidth.

Procedure:

a. Connect AC VTVM to the junction of R-316, R-333, and C-330.

b. Remove all connections from Pin 1, V-303. Connect a 47 ohm resistor from Pin 1, V-303 to ground, and connect the Signal Generator to Pin 1, V-303. Set the signal generator to 1.425 Mc 400 cps 30% modulation. Adjust the signal generator output to produce a usable indication on the AC VTVM.

c. Vary the signal generator frequency across the LF IF response. It will be noted that the IF response peaks approximately 10 Kc either side of 1.425 Mc, with 1.425 Mc falling at the bottom of a "hole" or "dip" in the response between the two peaks. See Figure 3, page 30, for the low frequency IF response. Use the AC VTVM indication at this "hole" in the response, at 1.425 Mc, as the reference level to measure bandwidth.

d. With the reference level set, increase the signal generator output 6 db (2:1). Tune the signal generator frequency below 1.425 Mc until the reference level is obtained on the AC VTVM. Note this frequency. Tune the signal generator frequency above 1.425 Mc until the reference level is obtained on the AC VTVM. Note this frequency. The difference between the two noted frequencies is the total 6 db bandwidth.

e. With the reference level set, increase the signal generator output 60 db (1000:1). Tune the signal generator frequency below 1.425 Mc until the reference level is obtained on the AC VTVM. Note this frequency. Tune the signal generator frequency above 1.425 Mc until the reference level is obtained on the AC VTVM. Note this frequency. The difference between the two noted frequencies is the total 60 db bandwidth.

f. Remove the signal generator and the 47 ohm resistor from Pin 1, V-303, and reconnect the components previously removed. Remove the AC VTVM from the junction of R-316, R-333 and C-330.

Normal Indication:

6 DB— 40 Kc minimum total bandwidth
60DB—200 Kc maximum total bandwidth

5-F,3. HF IF Amplifier.

Procedure:

a. Disconnect Pin 5, V-303 from T-301. See Figure 1, page 30, for dummy detector circuit. Connect the dummy detector as follows.

1. Connect the *B+* lead to +160 VDC.
2. Connect the *Plate* lead to Pin 5, V-303.
3. Connect the *A+* lead to 13.75 VDC.
4. Connect AC VTVM to the dummy detector output.

b. Remove all connections from Pin 1, V-302. Connect a 47 ohm resistor from Pin 1, V-302 to ground. Connect signal generator to Pin 1, V-302. Set the signal generator to a range covering 12 Mc, 400 cps 30% modulation.

c. Disconnect C-316 from C-344 and then ground disconnected end of C-316.

d. Set the fractional Mc selector to the 0.9 position. Set the signal generator to 12.35 Mc and adjust its output level for a usable indication on the AC VTVM. Adjust the primary and secondary tuning slugs of T-301 for maximum indication on the AC VTVM.

e. Set the fractional Mc selector to the 0.0 position. Set the signal generator to 11.45 Mc. Adjust C-314 and C-318 for maximum indication on the AC VTVM.

f. Repeat steps d. and e. until no further increase in AC VTVM indication is obtained.

g. Check the frequency at which the maximum indication on the AC VTVM is obtained on each fractional Mc selector position. This frequency should be no more than ±15 Kc from that position's center frequency.

h. Disconnect the AC VTVM and remove the dummy detector from Pin 5, V-303. Reconnect Pin 5, V-303 to T-302. Remove C-316 from ground and reconnect it to C-344. Remove the signal generator and the 47 ohm resistor from Pin 1, V-302 and connect the components previously removed.

Normal Indication:

Each fractional Mc position should be no more than ±15 Kc from its center frequency.

5-F,4. Low Frequency Oscillator.

PRIMARY METHOD

Procedure:

a. Determine that the HF IF is properly aligned.

b. Disconnect Pin 5, V-303 from T-302. Connect a 39 uhy choke from Pin 6, V-303 to Pin 5, V-303. Connect a 47 uufd 500V capacitor from Pin 5, V-303 to the input of the frequency counter. Remove all connections from Pin 1, V-302.

c. Set L-314 to mid-range. (Tuning screw half way in). Set C-345 to mid-range. (Slot for tuning tool horizontal with respect to the chassis).

d. Set the fractional Mc selector to the 0.9 position. Observe the frequency indicated on the counter. Adjust L-314 for an indication of 10.925 Mc on the counter.

e,. Set the fractional Mc selector to the 0.0 position. Observe the frequency indicated on the counter. Adjust C-345 for an indication of 10.025 Mc on the counter.

f. Repeat steps d. and e. until the circuit is tracked. Check the frequency of each fractional Mc position. The frequency must be within ±8 Kc of the center frequency for each position. See Table IV, page 30.

g. Reconnect the components previously removed from Pin 1, V-302. Remove the counter, 47 uufd capacitor, and 39 uhy choke from Pin 5 and Pin 6 of V-103. Reconnect Pin 5, V-303 to T-302.

ALTERNATE METHOD

Procedure:

a. Calibrate a BC-221 frequency meter to the nearest crystal check point related to the 10 Mc through 11 Mc range.

b. Connect a length of insulated wire (#22 hook up wire is adequate) to the antenna post of the BC-221. Insert the other end of the wire into the plate and screen area of V-303. Take care that the wire is well away from the control grid area of V-303 or oscillator frequency pulling will be experienced.

c. Set the fractional Mc selector to the 0.9 position. Set the BC-221 to 10.925 Mc. Adjust L-314 for a zero beat from the BC-221.

d. Set the fractional Mc selector to the 0.0 position. Set the BC-221 to 10.025 Mc. Adjust C-345 for a zero beat from the BC-221.

e. Repeat steps c. and d. until the circuit is tracked. Check the frequency of each fractional Mc position. The frequency must be within ±8 Kc of the center frequency for each position.

Normal Indication:

Each fractional Mc position must be no more than ±8 Kc from its center frequency.

5-F,5. Overall IF Gain.

Procedure:

a. Connect the AC VTVM to the junction of R-316, R-333 and C-330.

b. Remove all connections from Pin 1, V-302. Connect a 47 ohm resistor from Pin 1, V-302 to ground. Connect the signal generator to Pin 1, V-302. Set the signal generator to the 11 Mc through 13 Mc range, 1000 cps 30% modulation.

c. Set the fractional Mc selector to the 0.0 position. Set the signal generator to 11.45 Mc. Note the input required to produce 1.9 VAC as indicated on the AC VTVM.

d. Set the fractional Mc selector to the 0.5 position. Set the signal generator to 11.95 Mc. Note the input required to produce 1.9 VAC as indicated on the AC VTVM.

e. Set the fractional Mc selector to the 0.9 position. Set the signal generator to 12.35 Mc. Note the input required to produce 1.9 VAC as indicated on the AC VTVM.

f. A signal input of 20 uv maximum should produce 1.9 VAC detector output on all fractional Mc positions.

g. Remove the signal generator and the 47 ohm resistor from Pin 1, V-302, and reconnect the components previously removed. Remove the AC VTVM from the junction of R-316, R-333, and C-330.

Normal Indication:

20 μv maximum input for 1.9 VAC detector output.

5-F,6. High Frequency Oscillator.

Procedure:

a. Connect a DC VTVM through a 1 megohm resistor to Pin 2, V-305A.

b. Set the Mc selector to the 108 position. Adjust C-335 for minimum positive DC voltage indicated on the VTVM.

c. Set the Mc selector to the 117 position. Adjust L-309 for minimum positive DC voltage indicated on the VTVM.

d. Repeat steps b. and c. until no further decrease in positive DC voltage can be obtained.

e. Upon completion of step d., back the tuning screw at L-309 out (ccw) ¼ turn. Also back the tuning screw of C-335 out (ccw) ½ turn.

f. Check the positive DC voltage indicated on the VTVM for each Mc selector position (108 through 117). The DC level should be +5 to +8 volts.

g. Note that the non-oscillating potential on Pin 2, V-305A is approximately 13 VDC.

h. Remove the VTVM and the 1 megohm resistor Pin 2, V-305A.

Normal Indication:

+5 to +8 VDC on Pin 2, V-305A from 108 Mc through 117 Mc.

5-F,7. High Frequency Oscillator Conversion Gain.

Procedure:

a. Connect AC VTVM to the junction of R-316, R-333 and C-330.

b. Remove all connections, except C-310, from Pin 1, V-302. Connect a 47 ohm resistor from Pin 1, V-302 to ground, and connect the signal generator to Pin 1, V-302. Set the signal generator to the 108 Mc to 118 Mc range, 1000 cps 30% modulation.

c. Set the fractional Mc Selector to the 0.0 position. Set the Mc Selector to the 108 position. Set the Signal Generator to 108.0 Mc. Note the input level required to produce 1.9 VAC as indicated on the AC VTVM.

d. Set the fractional Mc selector to the 0.5 position. Set the Mc selector to the 112 position. Set the signal generator to 112.5 Mc. Note the input level required to produce 1.9 VAC as indicated on the AC VTVM.

e. Set the fractional Mc selector to the 0.9 position. Set the Mc selector to the 117 position. Set the Signal Generator to 117.9 Mc. Note the input level required to produce 1.9 VAC as indicated on the AC VTVM.

f. A signal input of 80 μv maximum should produce 1.9 VAC detector level on all channels.

g. Remove the signal generator and the 47 ohm resistor from Pin 1, V-302, and reconnect the components previously removed. Remove the AC VTVM from the junction of R-316, R-333, and C-330.

Normal Indication:

75 μv maximum input for 1.9 VAC detector output.

5-F,8. RF Amplifier.

Procedure:

a. Connect AC VTVM to the junction of R-316, R-333, and C-330.

b. Connect the signal generator to J-301.

c. Set the signal generator to the 108 - 118 Mc range, 1000 cps 30% modulation.

d. Set the fractional Mc selector to the 0.5 position. Set the Mc selector to the 108 position. Set the signal generator to 108.5 Mc and set its output for a usable indication on the AC VTVM. Adjust C-306 and C-308 for maximum indication on the AC VTVM.

e. Set the Mc selector to the 117 position. Set the signal generator to 117.5 Mc. Adjust L-301 for maximum indication on the AC VTVM.

f. Repeat steps d. and e. until no further increase in AC VTVM indication is obtained. Reduce the signal generator output to keep the detector level below 1.9 VAC (AVC threshold) during alignment.

g. A signal input of 2.5 μv maximum should produce 1.9 VAC detector output on all channels.

h. Remove the signal generator from J-301 and the AC VTVM from the junction of R-316, R-333, and C-330.

Normal Indication:
2.5 μv maximum input for 1.9 VAC detector output.

5-F,9. Sensitivity and Audio Output.

Procedure:

a. Connect the audio wattmeter to the speaker output.

b. Connect the signal generator to J-301. Set the signal generator to the 108 Mc to 118 Mc range, 1000 cps 30% modulation.

c. Set the fractional Mc selector to the 0.0 position. Set the Mc selector to the 108 position. Set the signal generator to 108.0 Mc. Note the input required to produce a 6 db difference between signal plus noise and noise.

d. Set the fractional Mc selector to the 0.5 position. Set the Mc selector to the 112 position. Set the signal generator to 112.5 Mc. Note the input required to produce a 6 db difference between signal plus noise and noise.

e. Set the fractional Mc selector to the 0.9 position. Set the Mc selector to the 117 position. Set the signal generator to 117.9 Mc. Note the input required to produce a 6 db difference between signal plus noise and noise.

f. A signal input of 1.3 μv maximum should produce 6 db signal plus noise to noise at the speaker output on all channels.

g. A signal input of 3 μv maximum should produce 4.5 watts at the speaker output on all channels.

h. Remove the signal generator from J-301 and the audio wattmeter from the speaker output.

Normal Indication:

1.3 μv maximum input for 6 db signal plus noise to noise at the speaker output.

3 μv maximum input for 4.5 watts at the speaker output.

5-F,10. Automatic Volume Control (AVC).

The AVC threshold, that point at which the AVC bus starts to go negative, should occur at 1.9 VAC ±0.1 VAC detector level. The detector level is measured at the junction of R-316, R-333, and C-330. The AVC threshold is controlled by R-312. Its value is selected to provide the proper amount of current to set the AVC threshold at 1.9 VAC detector level.

The AVC characteristic is such that a change of signal input level from 10 μv to 10K μv should produce a maximum of 4 db increase in the audio output.

5-G. CONVERSION, 90 to 360 COMMUNICATION CHANNELS.

5-G,1. Fractional Megacycle Crystals. EL-2051 Kit 72019-105.

a. Installation.

This kit contains ten crystals which are to be installed in the low frequency oscillator crystal assembly. The LFO crystal assembly is located just to the rear of V-103 and V-204. It will be noted that this assembly contains crystals in every other crystal position only on both the top and bottom sides of the chassis.

Viewed from the top, front, install the highest frequency crystal of this kit (9.425 Mc) in the vacant crystal space on the extreme left — *nearest chassis edge*. NOTE: Descending crystal oscillator operating frequency is also ascending channel selector frequency; i.e., 9.475 Mc = .00, 8.525 Mc = .95. Install the remaining crystals, in descending frequency order, in the vacant crystal spaces working from left to right. When the top row is completed, five crystals should have been used.

Turn the chassis over. Install the remaining five crystals in the open crystal spaces in the bottom row. Viewed from the bottom, front, install the crystals in descending frequency order working from left to right.

Use care in soldering crystal leads to prevent heat damage to the crystal. Use extreme care in soldering the crystal leads to the pads on the printed circuit to prevent lifting of the pads due to excessive heat. Do not bend crystal leads at a right angle at the point where they emerge from the crystal case. This could fracture the glass seal.

b. Detent Arrangement.

The fractional Mc detent is located at the rear of the chassis on the top side between T-101 and T-102. It will be noted that this detent has a star wheel on each end. On the one end, toward the front of the unit, a ten position star wheel; on the other end, toward the rear of the unit, a twenty position star wheel. This detent must be reversed, or turned around, so that the twenty position star wheel is toward the front of the unit.

The detent is secured by two screws, and it can be removed from its mounting shaft when these screws are loosened. Before removing the detent, set the fractional Mc selector to a position where the rotor tabs of the crystal assembly or of the HF IF step inductors can be observed. Note, at the same time, the frequency indicated by the fractional Mc dial. This is necessary so that proper indexing can be re-established easily.

Remove the detent spring and the detent roller from the detent assembly. Then loosen the two set screws in the dual star wheel assembly and slide the assembly to the rear of the Unit and off the shaft. In the event there is insufficient space to completely remove the star wheel assembly from the shaft, it will be necessary to remove the "COM" Fractional Mc Knob and loosen the set screws securing the Fractional Mc dial to its shaft. The fractional Mc shaft can then be moved forward enough to remove the star wheel assembly. Turn the star wheel assembly end for end so that the twenty position star wheel is toward the front of the unit, then slide it back on its shaft. Now replace the detent roller and detent spring. Note that the long end of the detent spring shall be retained in position, by placing this end on the inside of the outermost tab on the detent mounting plate. Check the rotor tabs at the chosen reference point for indexing, then secure the set screws in the star wheel assembly. Provide about .005 inch end play between the star wheel assembly and the bushing in the detent mounting plate. If the Fractional Mc Knob and dial have been loosened, re-secure them in their proper position as noted above.

After the final check of the assembly, a small amount of wide temperature range grease should be applied to the spring fulcrum, roller, and star wheel detent teeth.

5-G,2. Whole Megacycle Crystals. EL-2051 Kit 72019-102.

a. Installation.

This kit contains nine crystals which are to be installed in the high frequency oscillator crystal assembly. Viewed from the top, front, the HFO assembly is located on the left side approximately midway between the front and rear of the chassis. It is enclosed in a box. Remove the top and the bottom covers. Each is held in place by two machine screws.

Viewed from the front, top side, it will be noted that the HFO crystal assembly has three empty crystal spaces to the left of its top center, and six empty crystal spaces to the right of its top center. Install these nine crystals in these spaces, in ascending frequency order working from left to right. Use care in soldering crystal leads to prevent heat damage to the crystal. It may be necessary to remove C-241 and L-218 to install crystals in the last two spaces.

b. Stop Removal.

The stop on the Mc selector detent plate at the 126 position must now be broken out. To gain access to this stop, the knobs, mask, and trim panel must be removed. Before disassembly of the front panel, it is well to set the selectors to a reference frequency position for re-assembly. Removal of the front panel assembly will reveal the detent plate. The stop will be located on the rear side at the bottom and center of the detent plate. The stop is merely a lance, approximately 1/16 of an inch wide, in the detent plate itself. Break this stop out, and the Mc selector will channel to the 135 position. Exercise care that the channel selectors indicate the proper channel when the front panel is re-assembled.

5-G,3. Post Conversion Check-out.

After the crystals are installed, the detents properly adjusted, and the HFO covers re-assembled, give the radio an operational performance check. Alignment of the HFO, the transmitter, and the receiver RF section should be checked. In the event realignment is necessary, refer to the appropriate part of the alignment procedure section of the Narco Mark 12 Instuction Manual. A new fequency check slip is required for the transmitter which reflects the original plus the new channels that have been activated.

SECTION 6
ILLUSTRATIONS

6-A. INTRODUCTION.

All of the various Tables, Diagrams and Photos (except the Electrical Circuit Schematics) referred to in the preceding sections have been collected in this section for convenient reference. This arrangement was chosen in preference to the arrangement where the illustrations are located on or near the pages where the subject is discussed. Such an arrangement tends to be inconvenient and confusing when the illustration is needed to cover more than one subject.

The arrangement of this manual is such that wherever it is practical the illustrations are upright with respect to the text for convenient use.

Section 7 Replacement Parts, follows this section.

Section 8, Schematics, follows the Replacement Parts section as the last item in the Manual. The Schematics are in the form of two-page "pullout" sheets which can be used while the pages of the text, illustrations, or parts list are open for use.

6-B. TABLES.

TABLE I

CRYSTAL FREQUENCY — HFO

COMMUNICATIONS TRANSCEIVER

Channel	Oscillator Fundamental Frequency (Mc)	Oscillator Doubler Frequency (Mc)
117	63.2375	126.475
118	63.7375	127.475
119	64.2375	128.475
120	64.7375	129.475
121	65.2375	130.475
122	65.7375	131.475
123	66.2375	132.475
124	66.7375	133.475
125	67.2375	134.475
126	67.7375	135.475
127	68.2375	136.475
128	68.7325	137.475
129	69.2375	138.475
130	69.7375	139.475
131	70.2375	140.475
132	70.7375	141.475
133	71.2375	142.475
134	71.7375	143.475
135	72.2375	144.475

TABLE II

CRYSTAL FREQUENCY — LFO

COMMUNICATIONS TRANSCEIVER

Channel	Transmit Crystal Frequency (Mc)	Receive Crystal Frequency (Mc)
.00	9.475	8.975
.05	9.425	8.925
.10	9.375	8.875
.15	9.325	8.825
.20	9.275	8.775
.25	9.225	8.725
.30	9.175	8.675
.35	9.125	8.625
.40	9.075	8.575
.45	9.025	8.525
.50	8.975	9.475
.55	8.925	9.425
.60	8.875	9.375
.65	8.825	9.325
.70	8.775	9.275
.75	8.725	9.225
.80	8.675	9.175
.85	8.625	9.125
.90	8.575	9.075
.95	8.525	9.025

TABLE III
CRYSTAL FREQUENCY — HFO
NAVIGATION RECEIVER

Channel	Crystal Frequency (Mc)
108	96.55
109	97.55
110	98.55
111	99.55
112	100.55
113	101.55
114	102.55
115	103.55
116	104.55
117	105.55

TABLE IV
OSCILLATOR FREQUENCY — LFO
NAVIGATION RECEIVER

Channel	Center Frequency (Mc)
.0	10.025
.1	10.125
.2	10.225
.3	10.325
.4	10.425
.5	10.525
.6	10.625
.7	10.725
.8	10.825
.9	10.925

TABLE V

P-301 Terminal No.	Wire Color	Wire Size	Circuit Function
1	Grey	#18	Ground
2	Black	#18	+ DC Supply
3	No. Conn.	—	—
4	White/ Blue Tr.	#22	Omni/Loc. Relay
5	Blue	#22	Ext. Dim. for VOR
6	Green	#22	Omni Signal

6-C. DIAGRAMS.

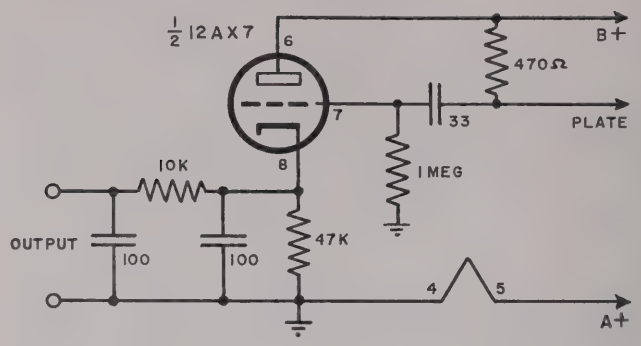


Figure 1.
TEST DETECTOR, High Impedance Type.

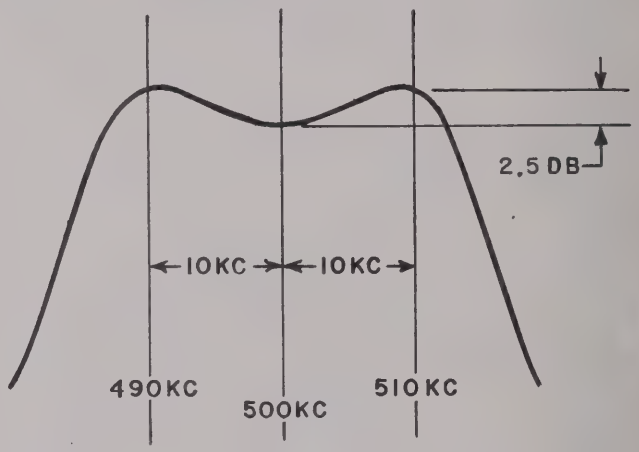


Figure 2.
narco Mark-12 COM. Receiver,
L.F. I.F. Response.

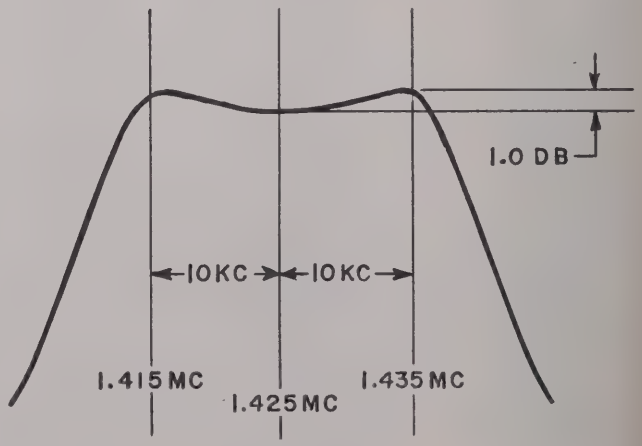
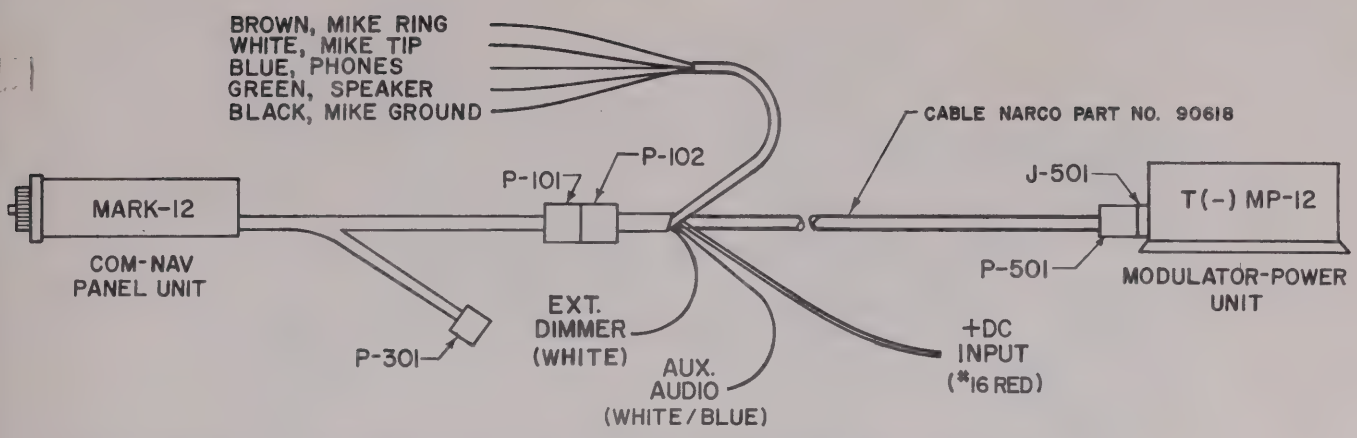


Figure 3.
narco Mark-12 NAV. Receiver.
L.F. I.F. Response.



NOTE - CONNECTORS ON BOTH ENDS OF CABLE 90618 ARE ALIKE BUT EQUIPMENT WILL OPERATE ONLY WHEN CABLE IS INSTALLED AS SHOWN, WITH POWER AND ACCESSORY WIRES AT PANEL UNIT END.

Figure 4.
narco Mark-12 INTERCONNECTING CABLE,
Power and Accessories.

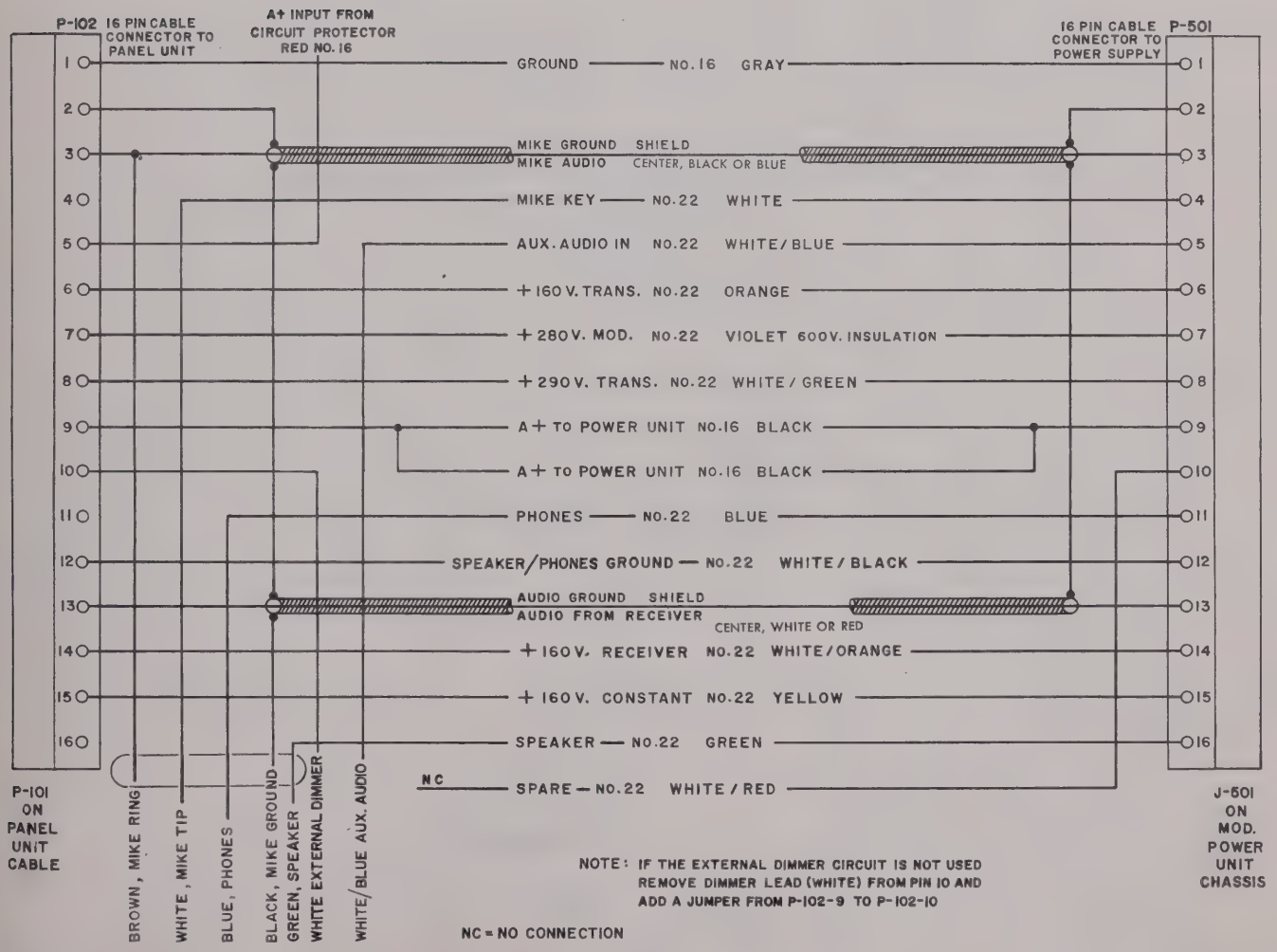

P-102 16 PIN CABLE CONNECTOR TO PANEL UNIT
A+ INPUT FROM CIRCUIT PROTECTOR RED NO. 16
16 PIN CABLE CONNECTOR TO POWER SUPPLY P-501
1 GROUND — NO. 16 GRAY 1
2 2
3 MIKE GROUND SHIELD
MIKE AUDIO CENTER, BLACK OR BLUE 3
4 MIKE KEY — NO. 22 WHITE 4
5 AUX. AUDIO IN NO. 22 WHITE/BLUE 5
6 +160 V. TRANS. NO. 22 ORANGE 6
7 +280 V. MOD. NO. 22 VIOLET 600V. INSULATION 7
8 +290 V. TRANS. NO. 22 WHITE/GREEN 8
9 A+ TO POWER UNIT NO. 16 BLACK 9
10 A+ TO POWER UNIT NO. 16 BLACK 10
11 PHONES — NO. 22 BLUE 11
12 SPEAKER/PHONES GROUND — NO. 22 WHITE/BLACK 12
13 AUDIO GROUND SHIELD
AUDIO FROM RECEIVER
CENTER, WHITE OR RED 13
14 +160 V. RECEIVER NO. 22 WHITE/ORANGE 14
15 +160 V. CONSTANT NO. 22 YELLOW 15
16 SPEAKER — NO. 22 GREEN 16
NC
SPARE — NO. 22 WHITE/RED
P-101 ON PANEL UNIT CABLE
J-501 ON MOD. POWER UNIT CHASSIS
BROWN, MIKE RING
WHITE, MIKE TIP
BLUE, PHONES
BLACK, MIKE GROUND
GREEN, SPEAKER
WHITE EXTERNAL DIMMER
WHITE/BLUE AUX. AUDIO
NOTE: IF THE EXTERNAL DIMMER CIRCUIT IS NOT USED REMOVE DIMMER LEAD (WHITE) FROM PIN 10 AND ADD A JUMPER FROM P-102-9 TO P-102-10
NC = NO CONNECTION

Figure 5.
narco Mark-12 CABLE CONNECTIONS,
Power and Accessories.

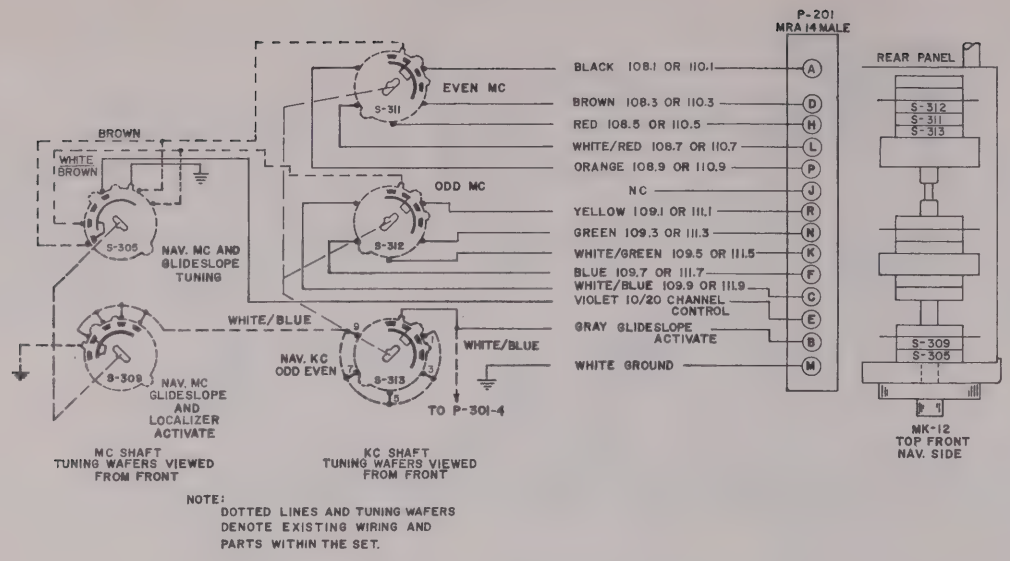


Figure 6.
narco Mark-12 Glide Slope Channel Selector
Switch Wiring.

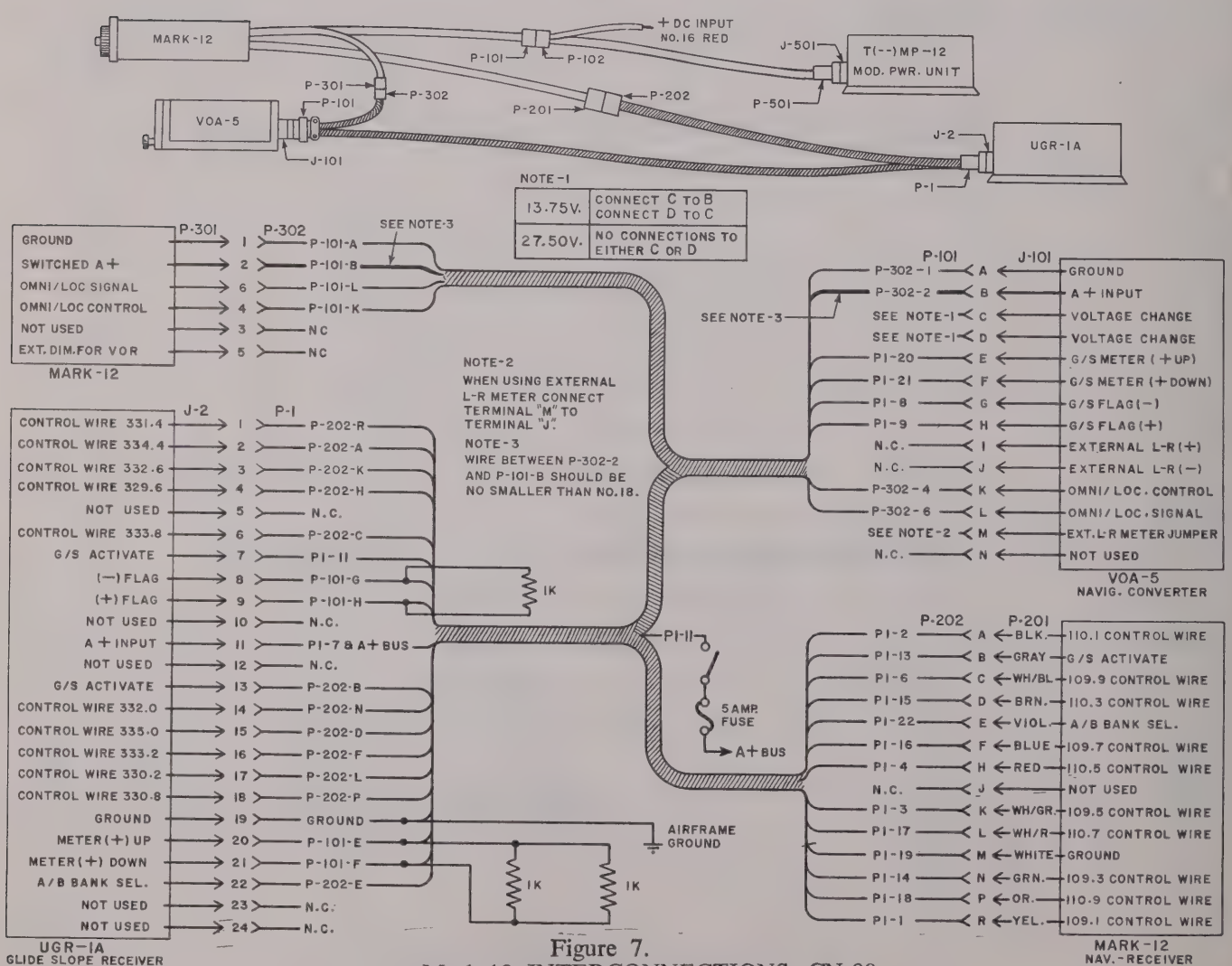


Figure 7.
narco Mark-12 INTERCONNECTIONS, CN-89,
with *narco* VOA-5 and *narco* UGR-1A.

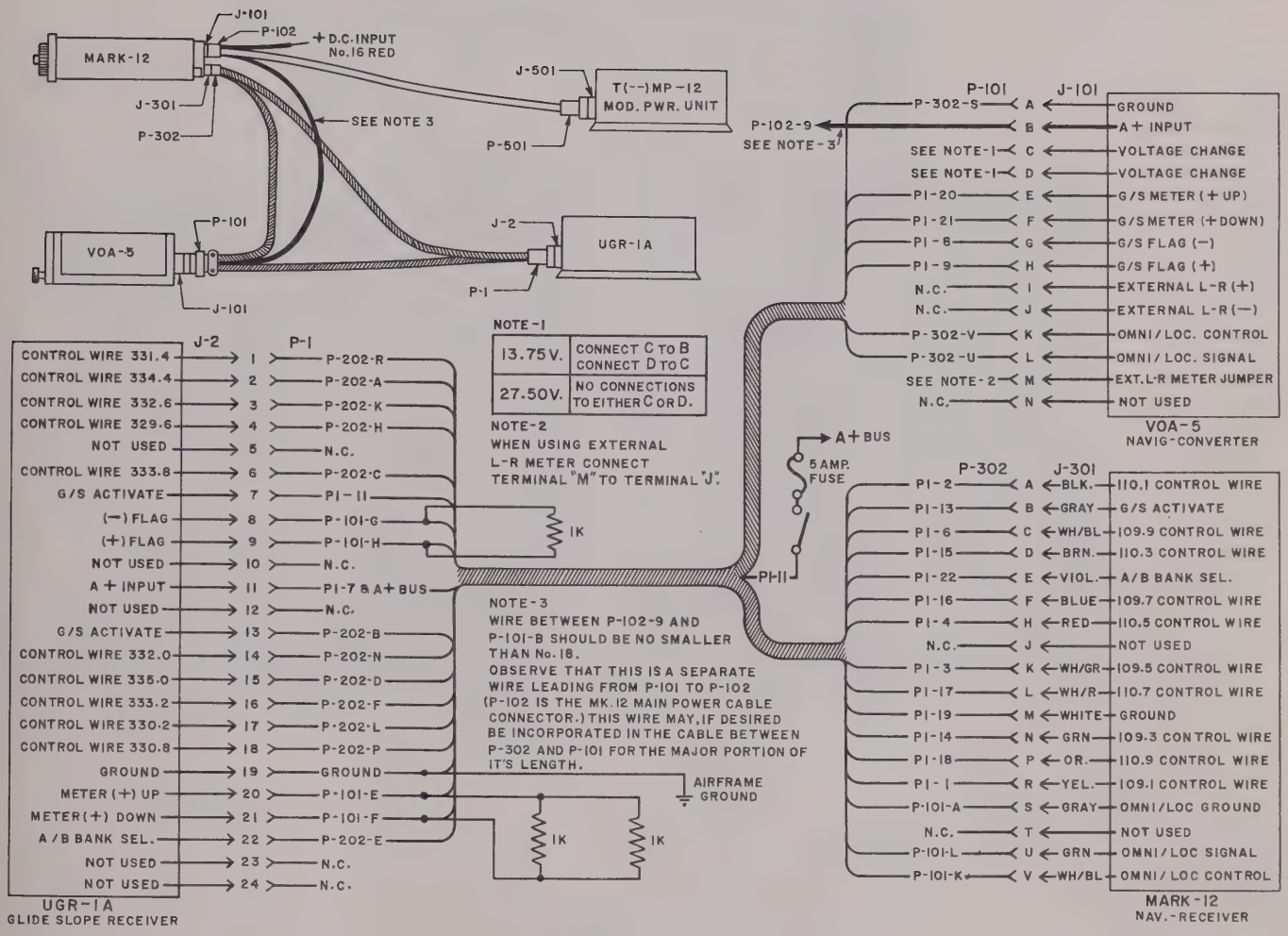

MARK-12
J-101
P-102
+D.C. INPUT No.16 RED
J-301
P-302
SEE NOTE 3
J-501
T(--)MP-12 MOD. PWR. UNIT
P-501
VOA-5
P-101
J-101
J-2
UGR-1A
P-1
NOTE-1
13.75V. CONNECT C TO B CONNECT D TO C
27.50V. NO CONNECTIONS TO EITHER C OR D.
NOTE-2
WHEN USING EXTERNAL L-R METER CONNECT TERMINAL "M" TO TERMINAL "J".
NOTE-3
WIRE BETWEEN P-102-9 AND P-101-B SHOULD BE NO SMALLER THAN No. 18.
OBSERVE THAT THIS IS A SEPARATE WIRE LEADING FROM P-101 TO P-102 (P-102 IS THE MK. 12 MAIN POWER CABLE CONNECTOR.) THIS WIRE MAY, IF DESIRED BE INCORPORATED IN THE CABLE BETWEEN P-302 AND P-101 FOR THE MAJOR PORTION OF IT'S LENGTH.
1K
1K
1K
AIRFRAME GROUND
A+ BUS
5 AMP. FUSE
P1-11
P-102-9
SEE NOTE-3
P-101 J-101
P-302-S A GROUND
B A+ INPUT
SEE NOTE-1 C VOLTAGE CHANGE
SEE NOTE-1 D VOLTAGE CHANGE
P1-20 E G/S METER (+UP)
P1-21 F G/S METER (+DOWN)
P1-8 G G/S FLAG (-)
P1-9 H G/S FLAG (+)
N.C. I EXTERNAL L-R (+)
N.C. J EXTERNAL L-R (-)
P-302-V K OMNI/LOC. CONTROL
P-302-U L OMNI/LOC. SIGNAL
SEE NOTE-2 M EXT. L-R METER JUMPER
N.C. N NOT USED
VOA-5 NAVIG-CONVERTER
P-302 J-301
P1-2 A BLK. 110.1 CONTROL WIRE
P1-13 B GRAY G/S ACTIVATE
P1-6 C WH/BL 109.9 CONTROL WIRE
P1-15 D BRN. 110.3 CONTROL WIRE
P1-22 E VIOL. A/B BANK SEL.
P1-16 F BLUE 109.7 CONTROL WIRE
P1-4 H RED 110.5 CONTROL WIRE
N.C. J NOT USED
P1-3 K WH/GR 109.5 CONTROL WIRE
P1-17 L WH/R 110.7 CONTROL WIRE
P1-19 M WHITE GROUND
P1-14 N GRN 109.3 CONTROL WIRE
P1-18 P OR. 110.9 CONTROL WIRE
P1-1 R YEL. 109.1 CONTROL WIRE
P-101-A S GRAY OMNI/LOC GROUND
N.C. T NOT USED
P-101-L U GRN OMNI/LOC SIGNAL
P-101-K V WH/BL OMNI/LOC CONTROL
MARK-12 NAV.-RECEIVER
J-2 P-1
CONTROL WIRE 331.4 1 P-202-R
CONTROL WIRE 334.4 2 P-202-A
CONTROL WIRE 332.6 3 P-202-K
CONTROL WIRE 329.6 4 P-202-H
NOT USED 5 N.C.
CONTROL WIRE 333.8 6 P-202-C
G/S ACTIVATE 7 P1-11
(-) FLAG 8 P-101-G
(+) FLAG 9 P-101-H
NOT USED 10 N.C.
A+ INPUT 11 P1-7 & A+ BUS
NOT USED 12 N.C.
G/S ACTIVATE 13 P-202-B
CONTROL WIRE 332.0 14 P-202-N
CONTROL WIRE 335.0 15 P-202-D
CONTROL WIRE 333.2 16 P-202-F
CONTROL WIRE 330.2 17 P-202-L
CONTROL WIRE 330.8 18 P-202-P
GROUND 19 GROUND
METER (+) UP 20 P-101-E
METER (+) DOWN 21 P-101-F
A/B BANK SEL. 22 P-202-E
NOT USED 23 N.C.
NOT USED 24 N.C.
UGR-1A GLIDE SLOPE RECEIVER

Figure 8.
narco Mark-12 INTERCONNECTIONS, CNP-89,
with *narco* VOA-5 and *narco* UGR-1A.

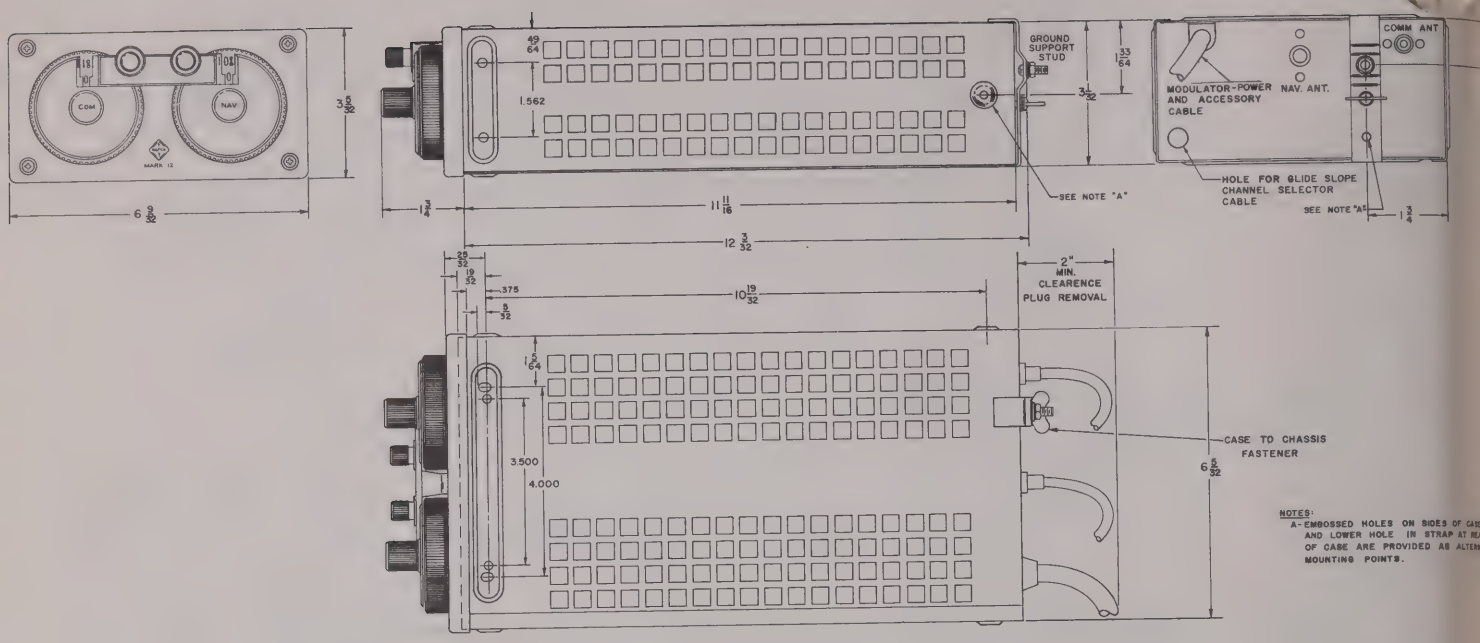


Figure 9.
narco Mark-12 PANEL UNIT, Mechanical Installation.

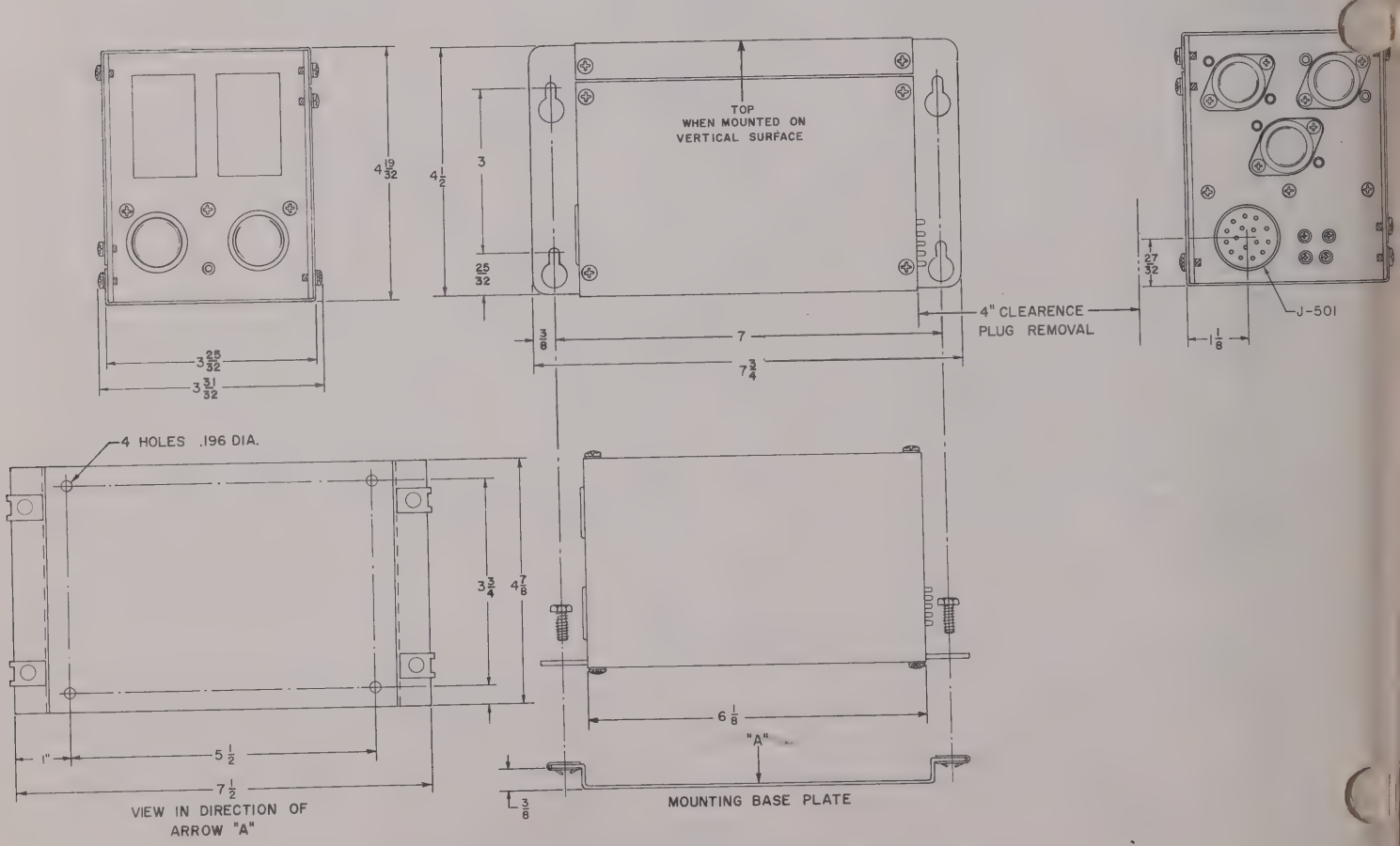


Figure 10.
narco MODULATOR-POWER UNIT, Mechanical Installation.

6-D. PHOTOS.

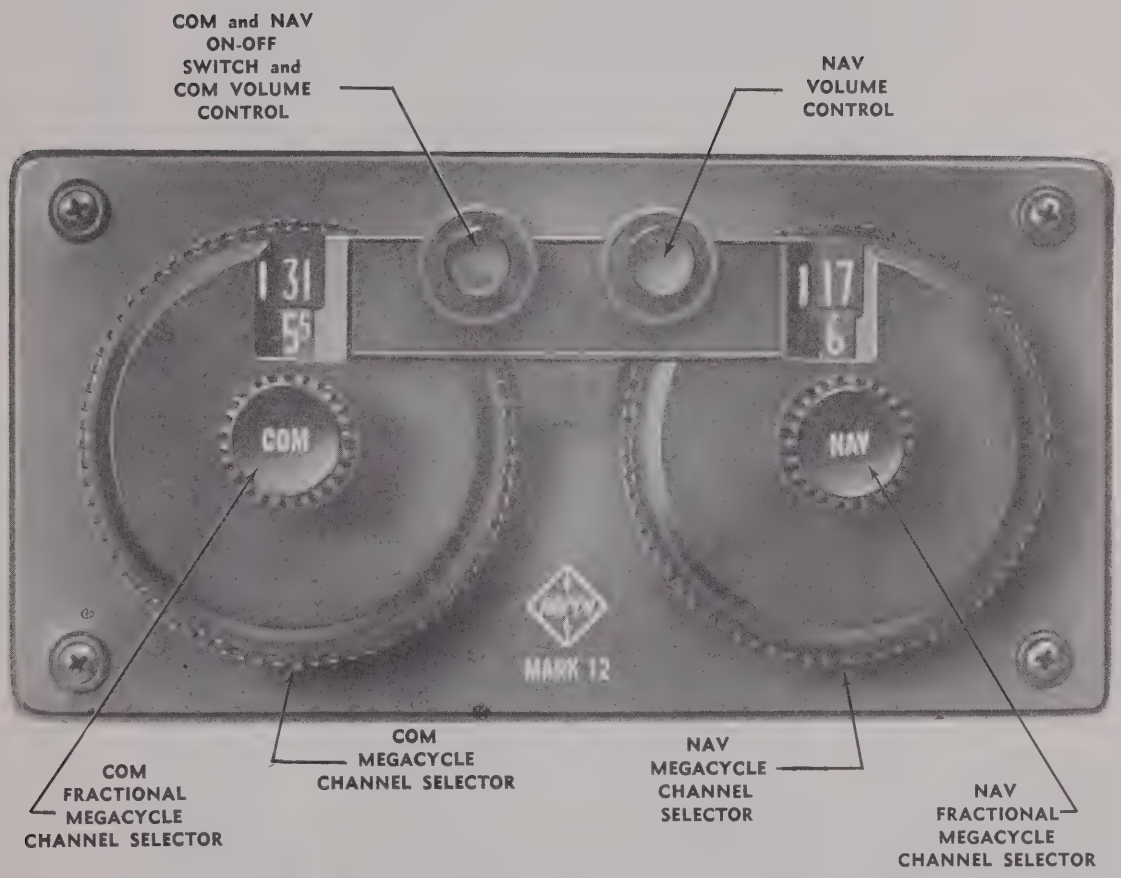


Photo A.
narco Mark-12 PANEL UNIT, Front View.

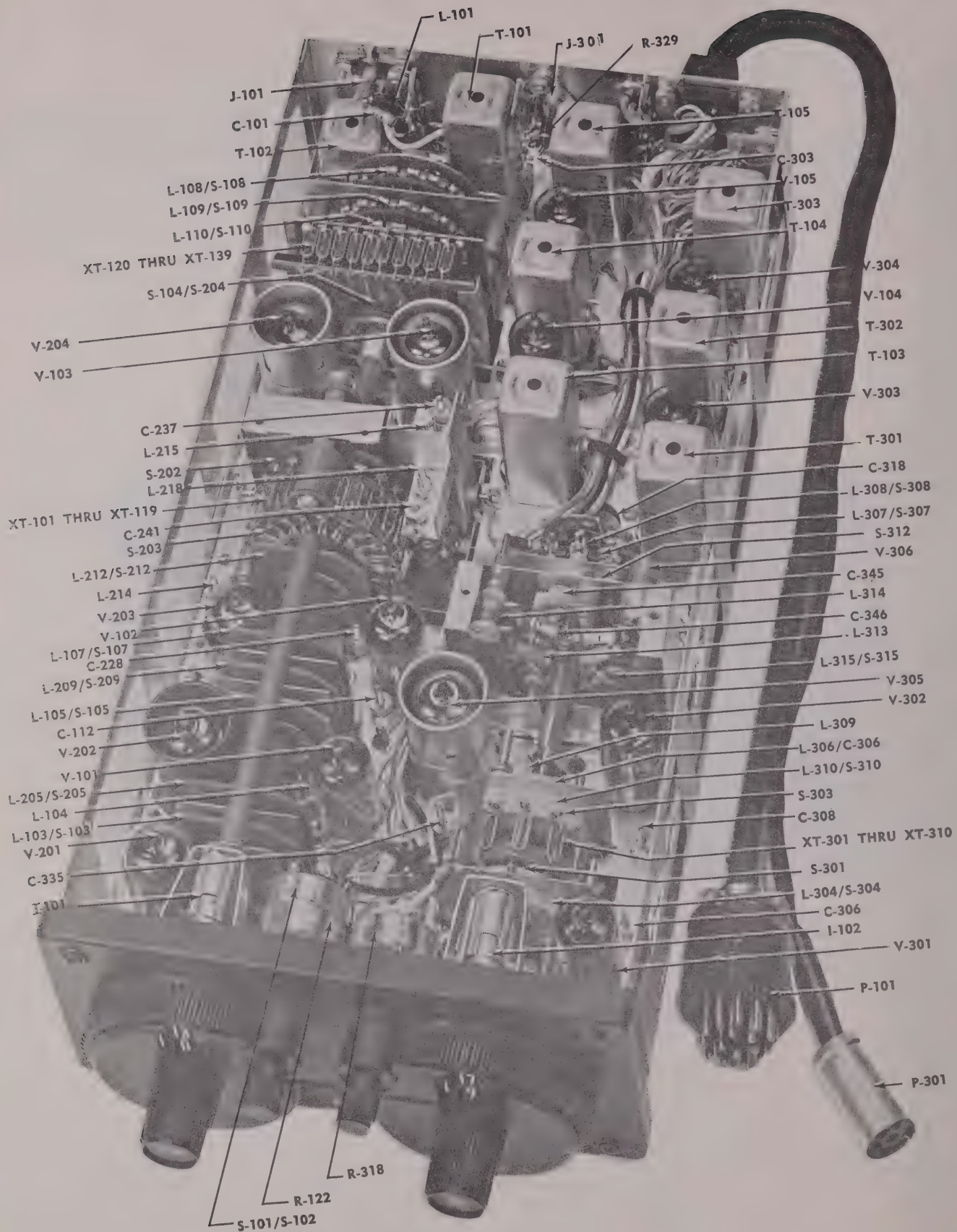
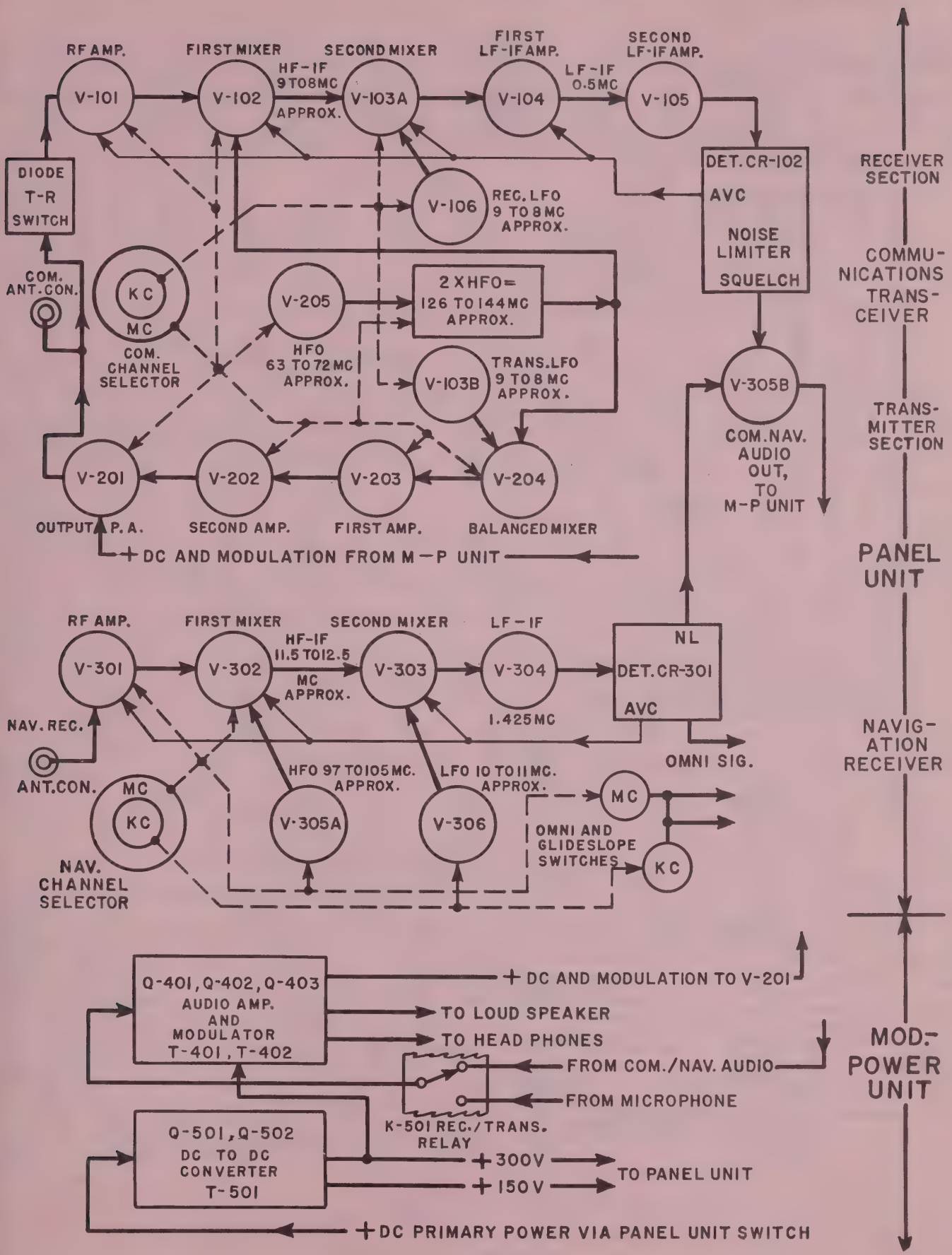


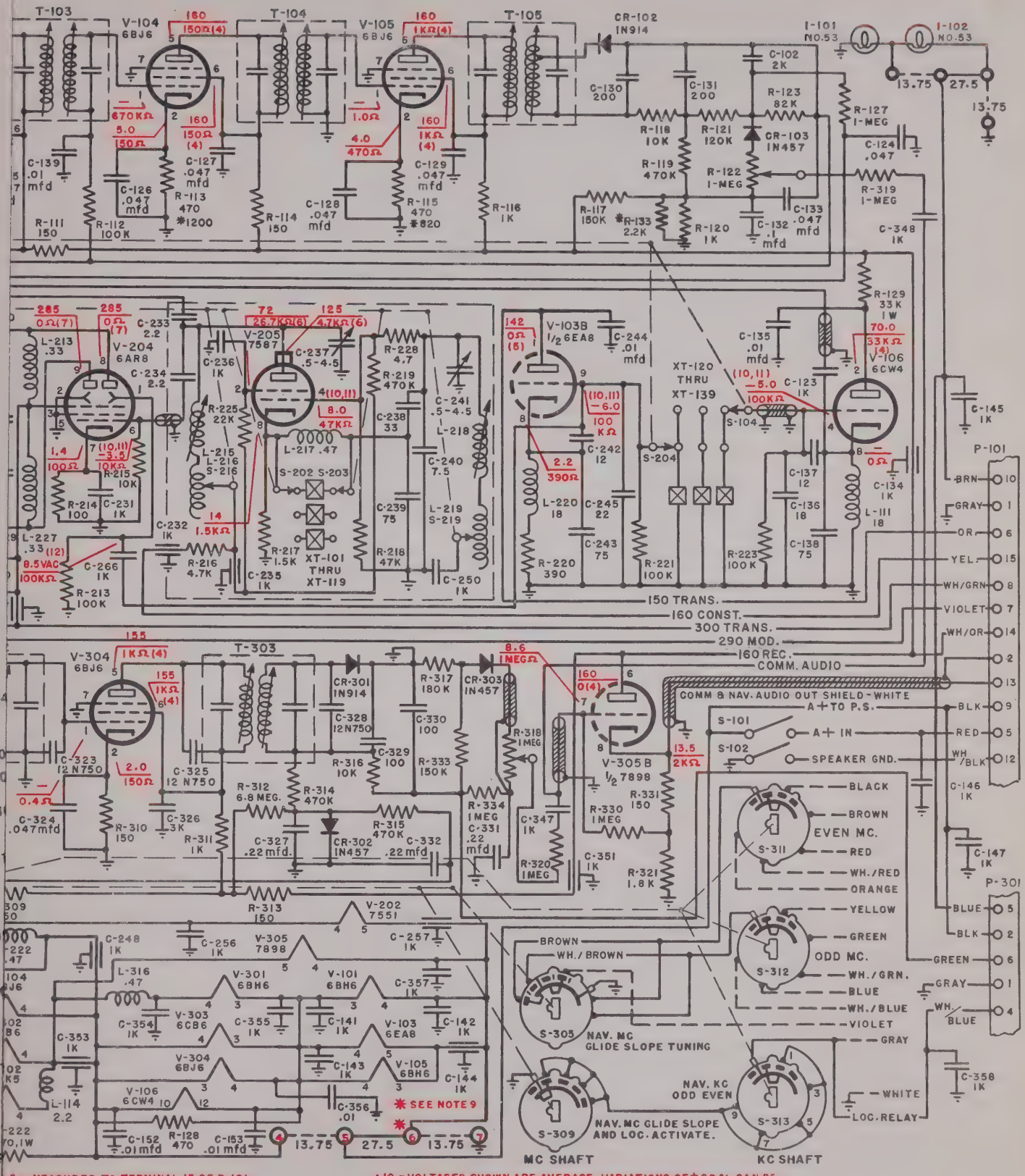
Photo B.
narco Mark-12 PANEL UNIT, Top Front, Right Side (OSC. Covers Removed), CN-89.



BLOCK DIAGRAM
narco Mark-12 COMMUNICATIONS TRANSCEIVER

		JUD BOX CONNECT	
E	MIKE AUDIO	2	
G	MIKE GND	1	#2
V	MIKE KEY	3	
N	SPEAKER	4	

3	MIKE AUDIO	2	
2	MIKE GND	1	
4	MIKE KEY	3	#1
16	SPEAKER	4	
11	PHONES	5	
5	AUX AUDIO	6	



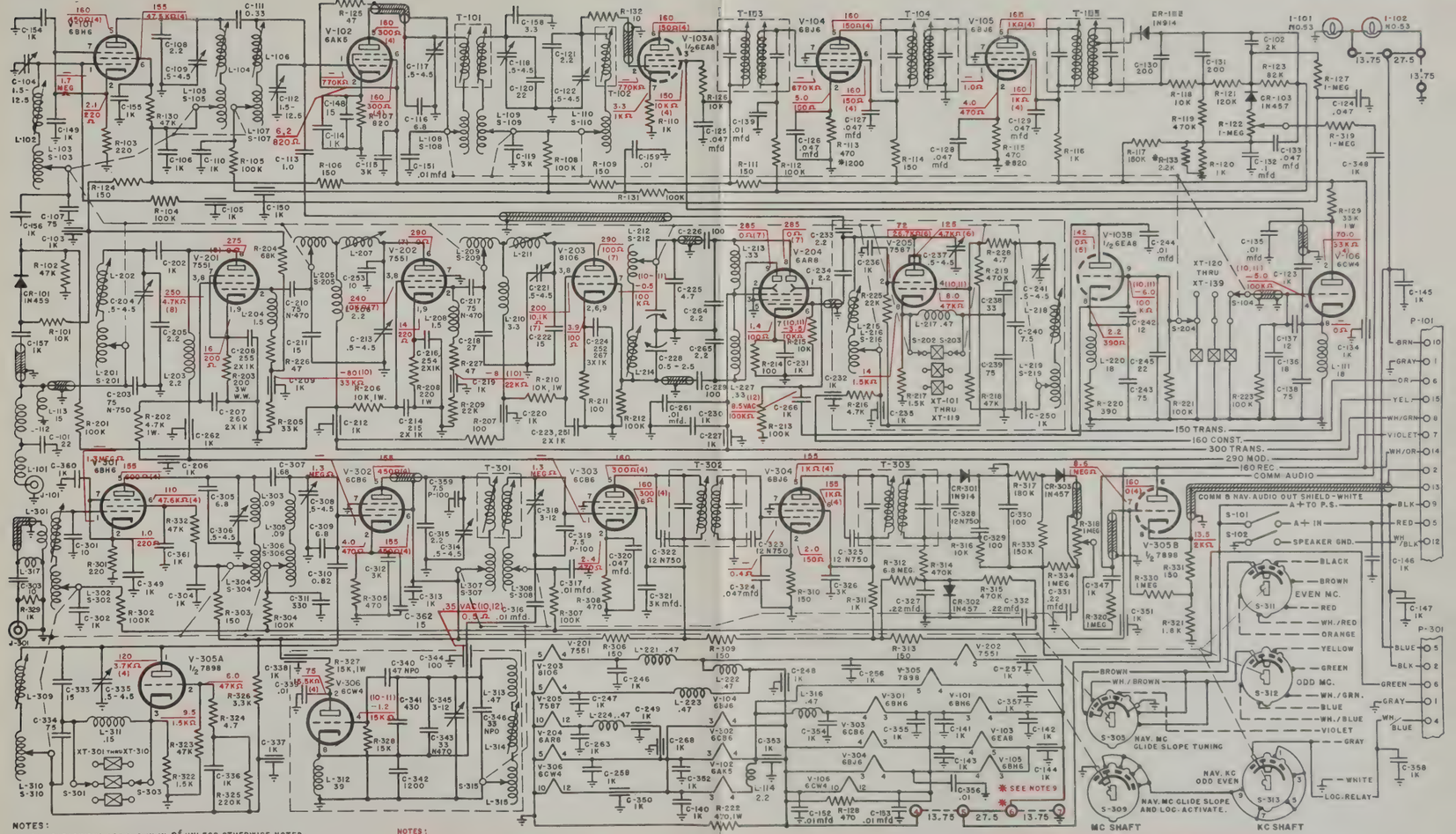
6.- MEASURED TO TERMINAL 15 OF P-101.
7.- MEASURED TO TERMINAL 8 OF P-101.
8.- MEASURED TO TERMINAL 7 OF P-101.
9.- TERMINALS 4,5,6, AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS. VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.
10.- VOLTAGES SHOWN ARE AVERAGE. VARIATIONS OF ± 20 % CAN BE EXPECTED.
11.- MEASURED THRU A 1 MEG. OHM RESISTOR.
12.- MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10 MC) VOLTMETER.
13.- VOLTAGE SHOWN ABOVE LINE - EXAMPLE VOLTAGE / RESISTANCE

Figure 11.

SCHEMATIC, *narco* Mark-12, PANEL UNIT
CN-89A and CNP-89A.

		END BOX CONNECT	
E	MIKE AUDIO	2	
G	MIKE GND	1	#2
V	MIKE KEY	3	
N	SPEAKER	4	

3	MIKE AUDIO	2	
2	MIKE GND	1	
4	MIKE KEY	3	#1
16	SPEAKER	4	
1	PHONES	5	
5	AUX AUDIO	6	



NOTES:
A.- ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
B.- ALL INDUCTORS ARE SHOWN IN MICRO-HENRIES UNLESS OTHERWISE NOTED.
C.- ALL RESISTORS ARE SHOWN IN ONE-HALF WATT UNLESS OTHERWISE NOTED.
D.- "K" DENOTES ONE THOUSAND. "M" DENOTES ONE MILLION.
E.- VALUES FOR R-113 & R-115 MARKED WITH (✱) ARE FOR CNP-89A CHASSIS ONLY.
F.- R-133 MARKED (✱✱) IS FOR CNP-89A CHASSIS ONLY.

NOTES:
1.- ALL RECEIVER VOLTAGES MEASURED WITH VOLUME CONTROLS FULL CCW, NO SIGNAL INPUT AND 13.75 V DC APPLIED TO UNIT.
2.- ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V DC APPLIED TO UNIT.
3.- ALL RESISTANCES MEASURED TO CHASSIS (GND.) UNLESS OTHERWISE NOTED.
4.- MEASURED TO TERMINAL 14 OF P-101.
5.- MEASURED TO TERMINAL 6 OF P-101.
6.- MEASURED TO TERMINAL 15 OF P-101.
7.- MEASURED TO TERMINAL 8 OF P-101.
8.- MEASURED TO TERMINAL 7 OF P-101.
9.- TERMINALS 4, 5, 6, AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS, VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.
10.- VOLTAGES SHOWN ARE AVERAGE. VARIATIONS OF ±20% CAN BE EXPECTED.
11.- MEASURED THRU A 1 MEG. OHM RESISTOR.
12.- MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10 MC) VOLTMETER.
13.- VOLTAGE SHOWN ABOVE LINE - EXAMPLE VOLTAGE / RESISTANCE

Figure 11.

SCHEMATIC, *narco* Mark-12, PANEL UNIT CN-89A and CNP-89A.

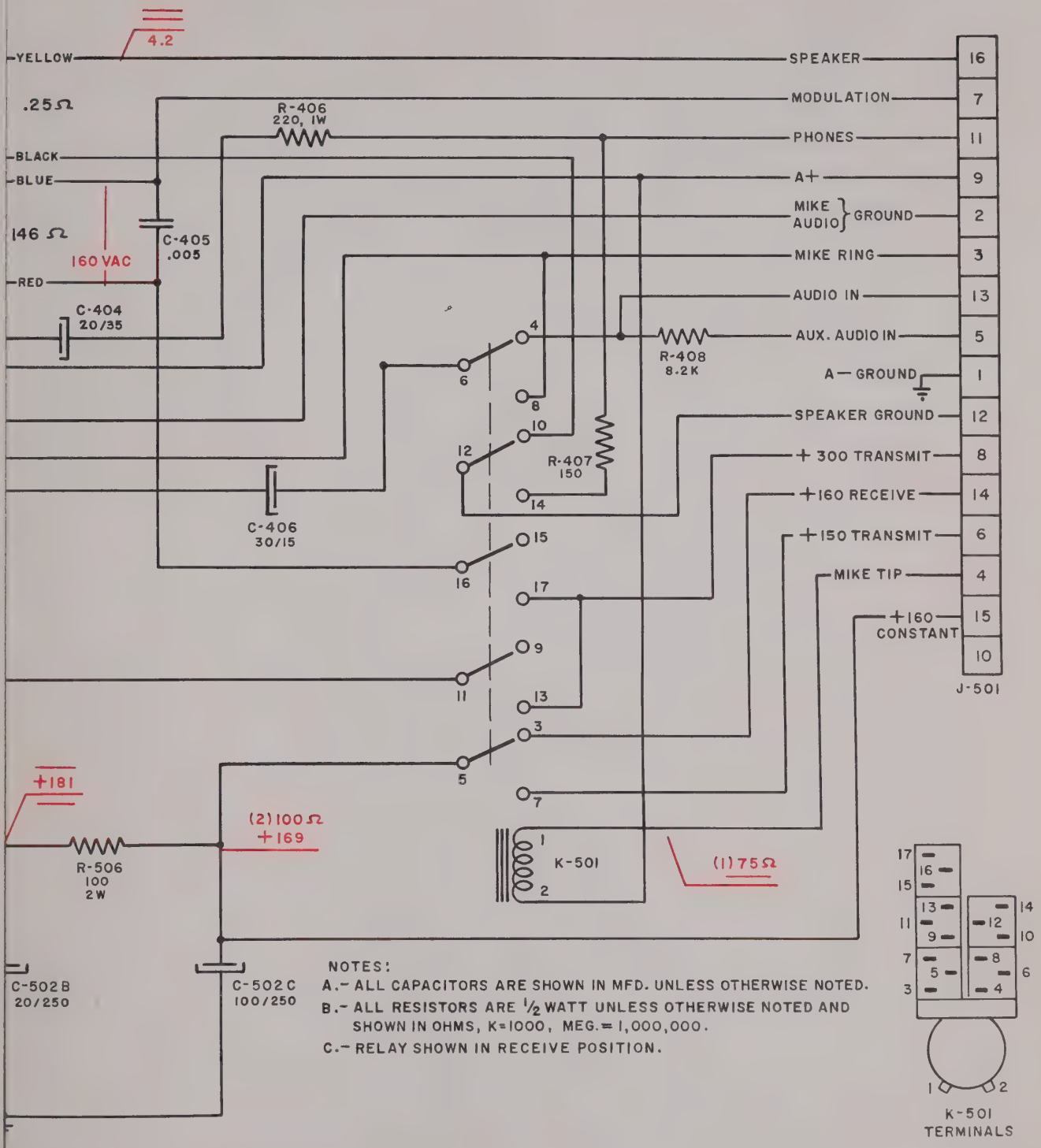
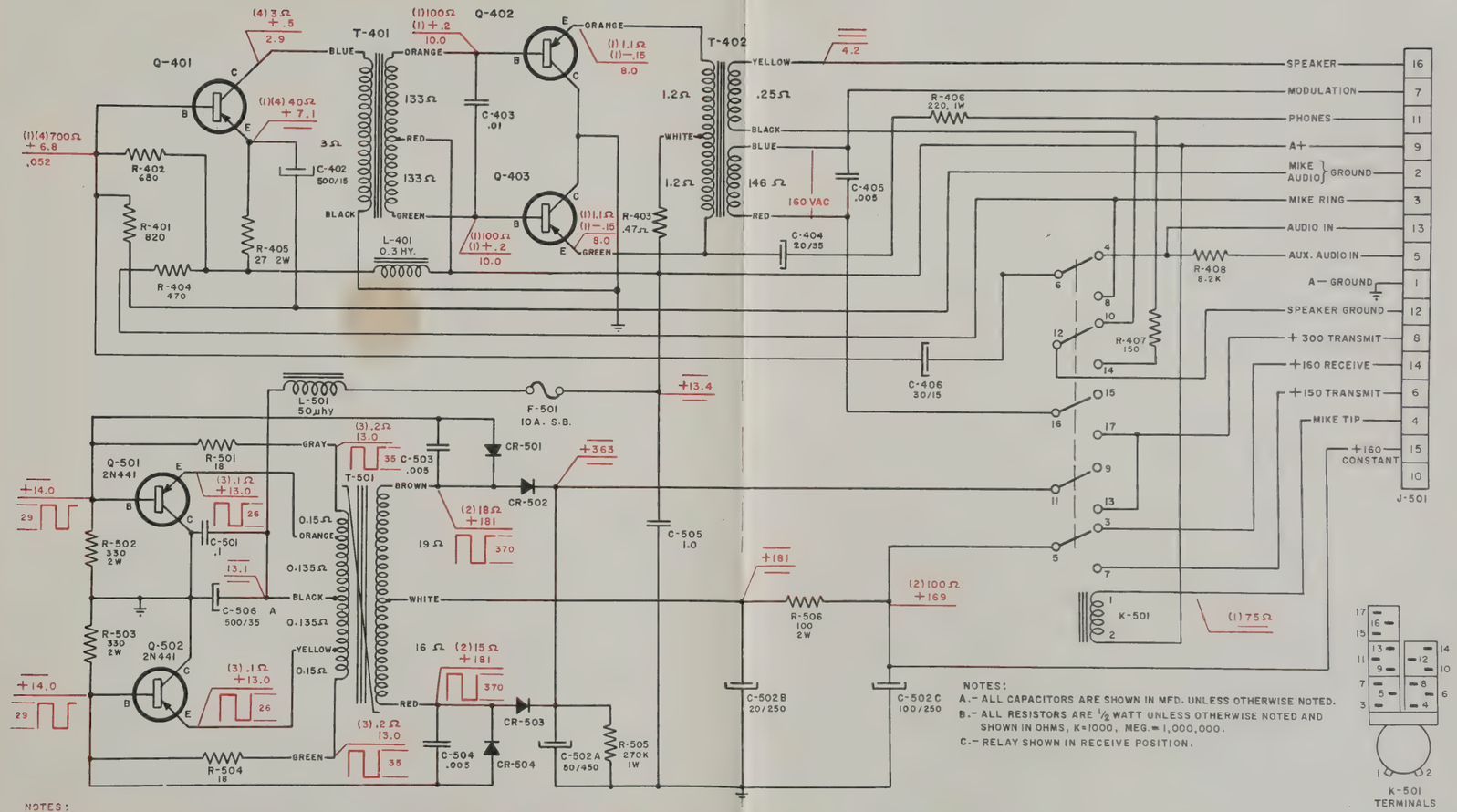


Figure 12.

SCHEMATIC, MODULATOR POWER UNIT, T-12MP-12, for ***narco*** Mark-12 operation on 12 Volts.
CNPA89-A



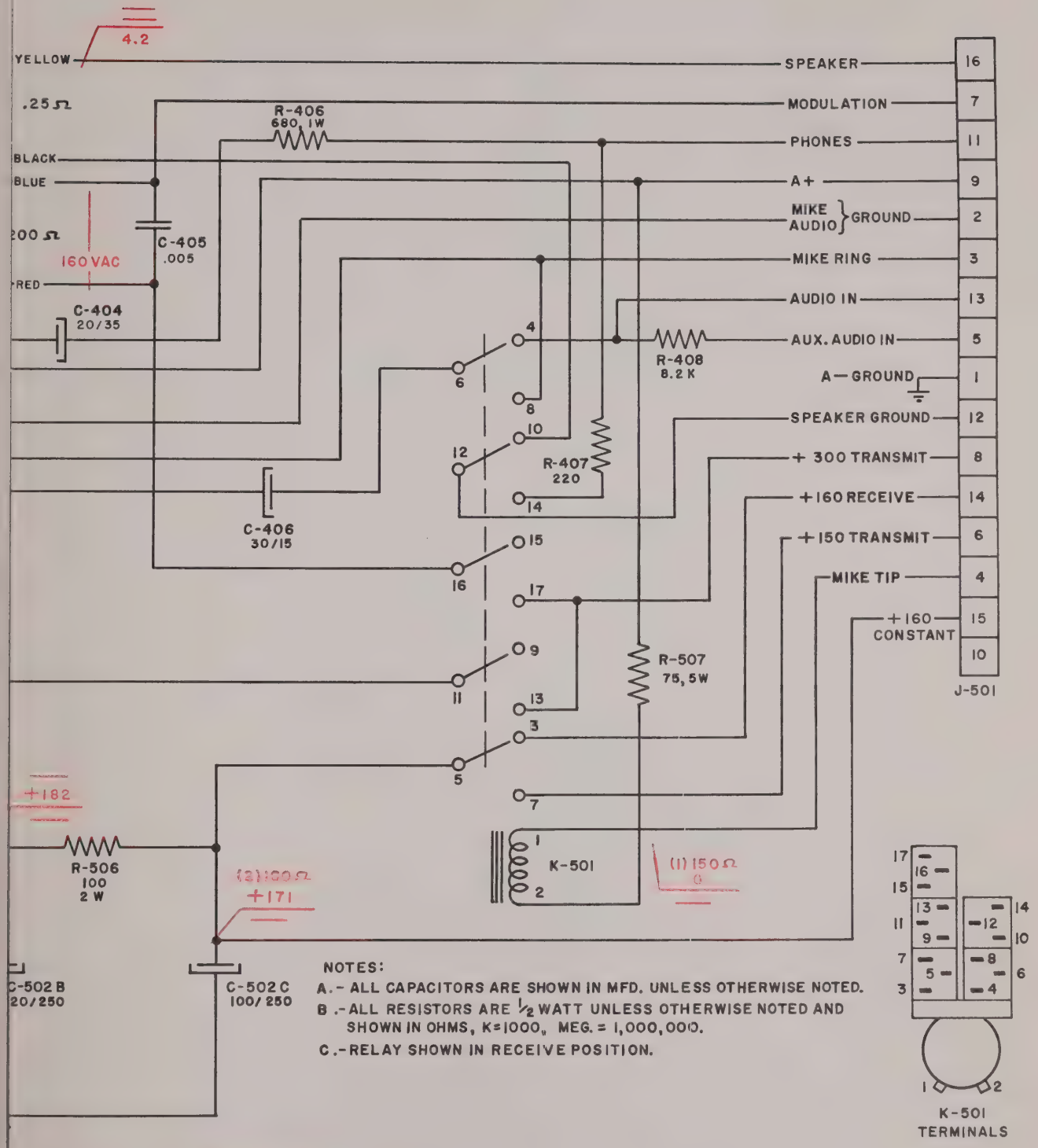
NOTES:
(1) - MEASURED WITH RESPECT TO A +, PIN-9.
(2) - MEASURED WITH RESPECT TO WHITE LEAD OF T-501.
(3) - MEASURED WITH RESPECT TO BLACK LEAD OF T-501.
(4) - MEASURED WITH Q-401 REMOVED.

RESISTANCE READING TAKEN WITH CONNECTOR DISCONNECTED.
OTHER READINGS ARE TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS OF AUDIO OUT, WITH NORMAL 13.75 V. INTO POWER CABLE AT MARK-12. (AUDIO FREQUENCY 1000 CYCLES)
ALL DC MEASUREMENTS ARE WITH RCA VOLTOHMIST VTVM OR EQUIVALENT.
ALL WAVEFORMS ARE MEASURED WITH A DUMONT 401B OSCILLOSCOPE OR EQUIVALENT.
ALL AC MEASUREMENTS WITH BALLANTINE AC VOLTMETER OR EQUIVALENT.

TEST DATA LINE
RESISTANCE
DC VOLTAGE AND POLARITY
AC VOLTAGE OR WAVE SHAPE & P-P VOLTAGE

NOTES:
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.
C.- RELAY SHOWN IN RECEIVE POSITION.

Figure 12.
SCHEMATIC, MODULATOR POWER UNIT, T-12MP-12, for *narco* Mark-12 operation on 12 Volts.
CNPA89-A



NOTES:

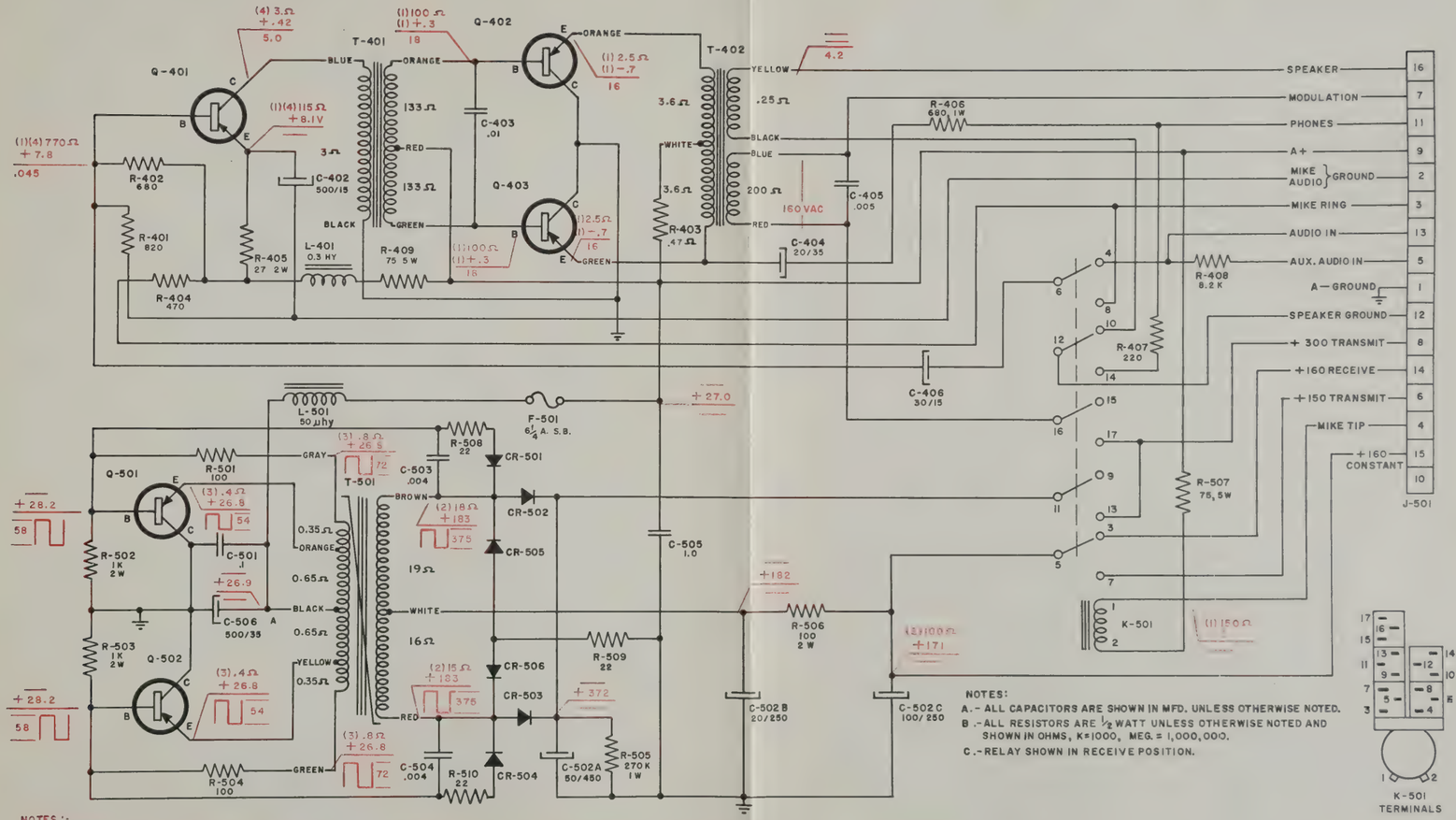
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.

B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG. = 1,000,000.

C.- RELAY SHOWN IN RECEIVE POSITION.

Figure 13.

SCHEMATIC, MODULATOR POWER UNIT T-24MP-12
for *narco* Mark-12 operation on 24 Volts.
CNPB89-A



NOTES :-
(1) - MEASURED WITH RESPECT TO A +, PIN-9.
(2) - MEASURED WITH RESPECT TO WHITE LEAD OF T-501.
(3) - MEASURED WITH RESPECT TO BLACK LEAD OF T-501.
(4) - MEASURED WITH Q-401 REMOVED.

RESISTANCE READINGS TAKEN WITH CONNECTOR DISCONNECTED
OTHER READINGS ARE TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS OF AUDIO OUT (FREQUENCY 1000 CYCLES), WITH NORMAL 27.5V. INTO POWER CABLE AT MARK-12.
ALL DC MEASUREMENTS ARE WITH RCA VOLTOHMIST VTVM OR EQUIVALENT.
ALL WAVEFORMS ARE MEASURED WITH A DUMONT 401B OSCILLOSCOPE OR EQUIVALENT.
ALL AC MEASUREMENTS WITH BALLANTINE AC VOLTMETER OR EQUIVALENT.

TEST DATA LINE
RESISTANCE
DC VOLTAGE AND POLARITY
AC VOLTAGE OR
WAVE SHAPE & P-P VOLTAGE

Figure 13.
SCHEMATIC. MODULATOR POWER UNIT T-24MP-12
for *narco* Mark-12 operation on 24 Volts.
CNPB89-A

NOTE—This sheet may be placed at the front of the original Manual MM-211.

MARK-12
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL

for

CN89-A and CNP89-A

with

CNPA89-A or CNPB89-A

and with

SUPPLEMENT No. 1

for

CN89-B and CNP89-B

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A. 3075-600 September, 1963

Supplement No. 1

For CN89-B and CNP89-B

MARK-12
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL

SUPPLEMENT No. 1

for

CN89-B and CNP89-B

with

Corrections, Changes and Additions

for the

Original Manual

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A.

3075-600

September, 1963

SECTION 1
GENERAL INFORMATION

1-A. INTRODUCTION.

This is Supplement No. 1 to the ***narco*** Mark-12 Maintenance Manual, MM-211, April 1963. It is concerned primarily with Panel Units having Chassis Numbers CN-89-B and CNP-89-B.

It also contains a few minor corrections, changes or additions to the original manual. The corrections, changes, or additions are referenced to the corresponding pages, sections, and paragraphs in the original manual.

1-A,1. Panel Unit

Add the following paragraph: (Ref. page 7)

A squelch control has been provided for the Communications Receiver. It is a small knob, marked "SQ.", concentric with the Communication Receiver Volume Control knob. These knobs are near the top of the panel, just to the left of the center. See PHOTO Aa., page 66.

1-B. SPECIFICATIONS.

1-B,3. Communications Receiver

Add the following item: (Ref. page 8)

Squelch.
Maximum squelch (knob fully counterclockwise) should be overcome by signal input levels of 10 to 25 microvolts.

SECTION 2
INSTALLATION

2-C. ACCESSORIES REQUIRED, but Not Supplied.

Corrections: (Ref. page 9)

Item 4. Delete the phrase: "See Section J,1., below."

Item 5. Should read:....., See Section 2-H,2., page 12.

Item 6. Should read:....., See Section 2-D,1,a., below.

2-D. OPTIONAL UNITS and ACCESSORIES AVAILABLE.

Addition: (Ref. page 10)

2-D,4. Tone Filter

a. Tone Filter, narco Type VP-12, ***narco*** Part No. EL-2070.

2-F. ELECTRICAL CONNECTIONS.

2-F,1. Modulator-Power and Accessory Cable.

Corrections: (Ref. page 10)

In the first line of the second paragraph read:..... (See 2-C., 1., page 9).....

2-F,2. Navigation Cable

In the fifth line of the first paragraph read:
.....are given in Table V, page 30 and in.....

2-F,3. Glide Slope Channel Selector Cable.

Correction: (Ref. page 11)

In the last line of the second paragraph read:
.....(See 2-D,1a., page 9).

2-J. POST-INSTALLATION CHECKOUT.

Add the following paragraph: (Ref. page 12)

With minimum squelch (knob fully clockwise) background noise should be present, on all channels, at the speaker output terminals.

SECTION 3
OPERATION

3-A. INTRODUCTION.

3-A,1. Panel Unit Controls.

Addition: (Ref. page 13)

Amend the first sentence of the introductory paragraph to read:

The controls consist of two Channel Selectors, two Volume Controls, an ON-OFF Primary DC Power Switch and a Squelch Control for the Communications Receiver.

Under:
a. Communication Transceiver.

Add the following paragraph:

The knob concentric with but behind the COM Volume Control Knob, operates the Squelch Control. It is marked "SQ". The weakest signals will be received with the "SQ" control in the maximum clockwise position.

SECTION 4
CIRCUIT DESCRIPTION

4-C. COMMUNICATIONS RECEIVER.

Additions: (Ref. pages 14 and 15)

Amend the last sentence of the third paragraph in the first column of page 15, to read:

The output of the audio volume control is applied via C-348, CR-104, C-161 and R-319 to the control grid of the cathode follower V-305-B.

Refer to the supplementary Schematic, Figure 11a., page 69.

Add the following two new paragraphs:

Squelch Control is accomplished by biasing a silicon diode, CR-104, "ON" or "OFF". This diode controls the signal of the Communications Receiver Audio to the cathode follower V-305-B. The diode (CR-104) is reverse biased "OFF" by turning the squelch control, R-138, in the counter-clockwise direction. This makes the DC voltage on the cathode (of CR-104) equal to or greater than that on its anode. The D.C. voltage on the anode of CR-104 is controlled by the screen grid voltage of the first LF IF Amplifier V-104.

When a signal is received AVC voltage will be developed, the current through V-104 will be reduced and its screen voltage will increase. This voltage increase is applied to the anode of CR-104 and forward biases it "ON". When the signal ceases the AVC voltage will disappear and the V-104 screen grid voltage will decrease. The anode voltage on CR-104 will, therefore, decrease causing it to return to the reverse biased "OFF" condition.

SECTION 5
MAINTENANCE

5-E. COMMUNICATIONS RECEIVER ALIGNMENT.

5-E,9. Automatic Volume Control (AVC)

First paragraph: (Ref. page 24)

Amend the last sentence to read: (Ref. page 24)

This potential with no signal applied, should be between minus 0.5 and minus 0.8 VDC.

Second paragraph.

Change the value 0.2 VDC to minus 0.5 VDC.

Third paragraph.

Change the value 0.2 VDC to minus 0.8 VDC.

Fourth paragraph

No change.

Add the following new subsection:

5-E,10. Squelch.

Refer to the supplementary Schematic, Figure 11a., page 69.

The squelch will operate with a very small signal input to the receiver. A signal input of 25 microvolts should overcome the maximum squelch (Squelch Control, R-138, in the maximum counter-clockwise position).

If a 25 microvolt signal will not overcome maximum squelch, the resistor R-139 (100K ohms) may be shunted with a value of resistance that will allow the signal to overcome the maximum CCW squelch setting.

If the squelch is overcome (opened) by too small an input signal (less than about 5 microvolts), the resistor R-136 (33K ohms) may be shunted with a value of resistance that will require an input signal of 10 to 25 microvolts to overcome the maximum counter-clockwise squelch setting.

Any adjustment of the squelch circuit should be done at the center frequency of the receiver tuning range.

SECTION 6
ILLUSTRATIONS

6-C. DIAGRAMS.

For convenience in making test setups to accommodate the OMNI/LOC circuits of both the CN-89 and CNP-89 Panel Units, note that the wire color codes on P-302, Fig. 8, page 33, correspond with those of P-301, Fig. 11, page 55 and P-301, Fig. 11a, page 69.

Also, note that the Glide Slope Channel Selector Circuits of P-302, Fig. 8, page 33, correspond in both wire color code and connector terminal letter with the circuits in Fig. 6, page 32.

To clarify the OMNI/LOC and Glide Slope circuit connections for the CNP-89 Panel Units a supplementary diagram, "Supplement No. 1 to Fig. 8, page 33 is provided herewith (See below).

A new Front Panel Photo showing the location of the SQUELCH Knob is provided, herewith, as PHOTO Aa., page 66.

Correction: (Ref. page 37)

The connector at the bottom left of Photo C, page 37 is incorrectly marked P-301. The correct designation is J-301, to correspond with the diagram Fig. 8, page 33.

Additions: (Ref. pages 36, 37, 38, and 39)

In order to show the location and arrangement of the components associated with the Squelch Control, two diagrams have been provided.

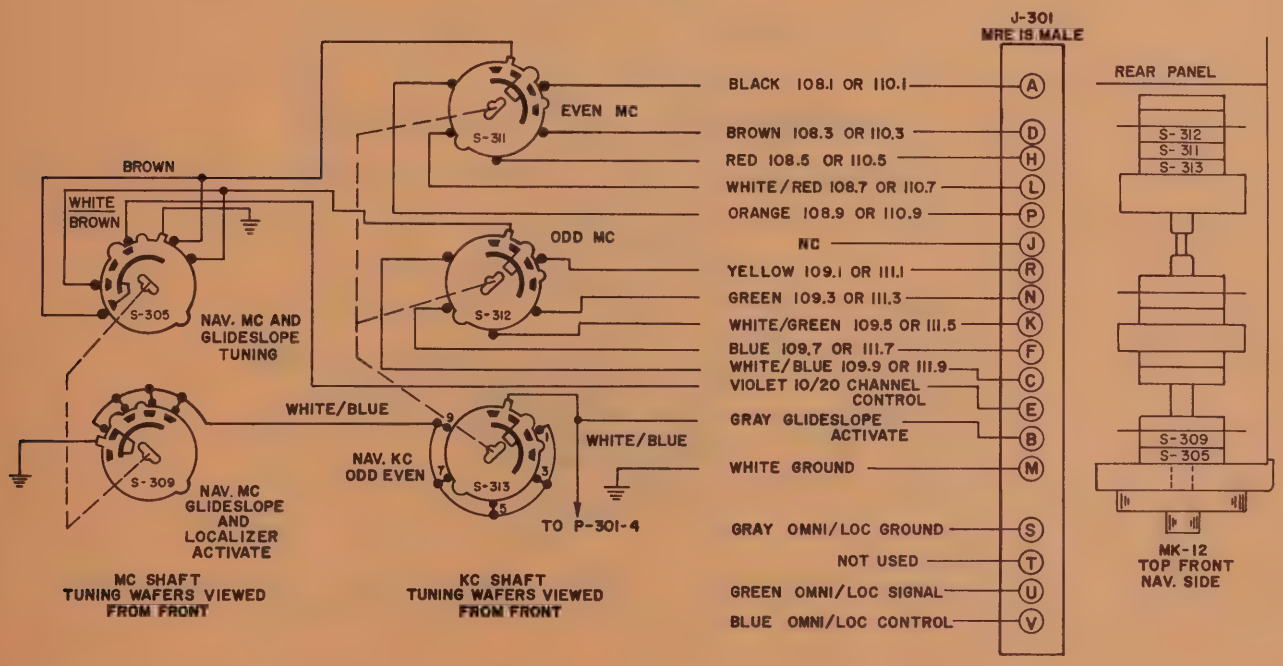
They are identified as:

TOP VIEW

Supplement No. 1, for PHOTOS B and C, pages 36 and 37. (See page 66.)

BOTTOM VIEW

Supplement No. 1, for PHOTOS D and E, pages 38 and 39. (See page 67)



SUPPLEMENT No. 1, to Fig. 8, page 33, GLIDE SLOPE CH. SEL. SW. WIRING, for CNP-89.

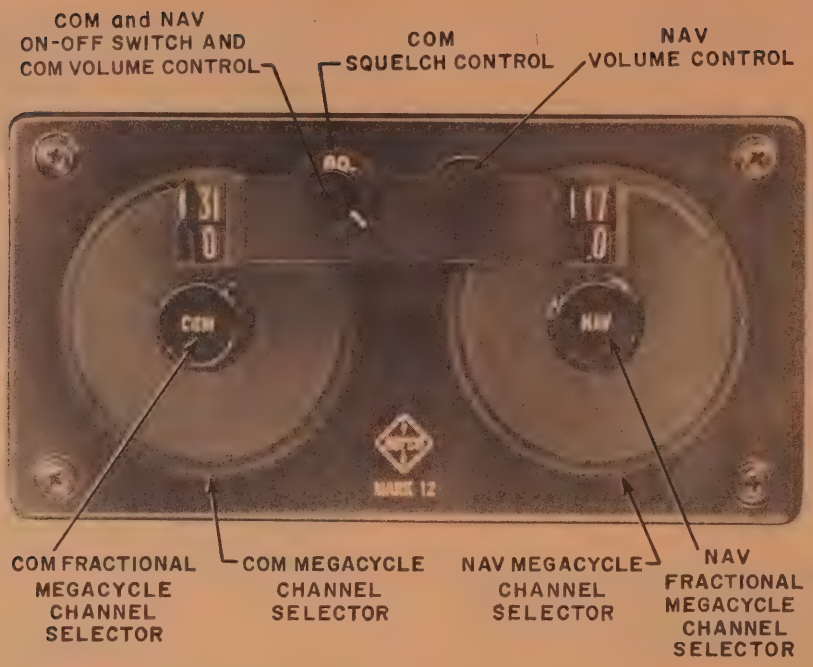
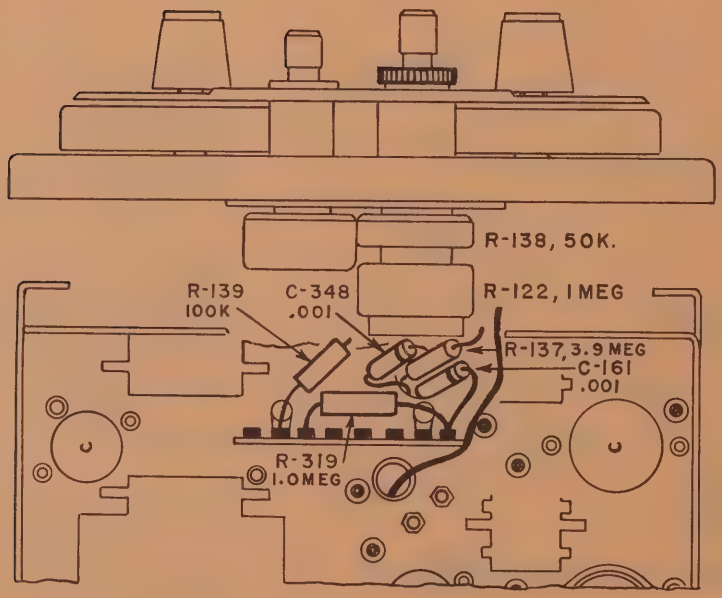
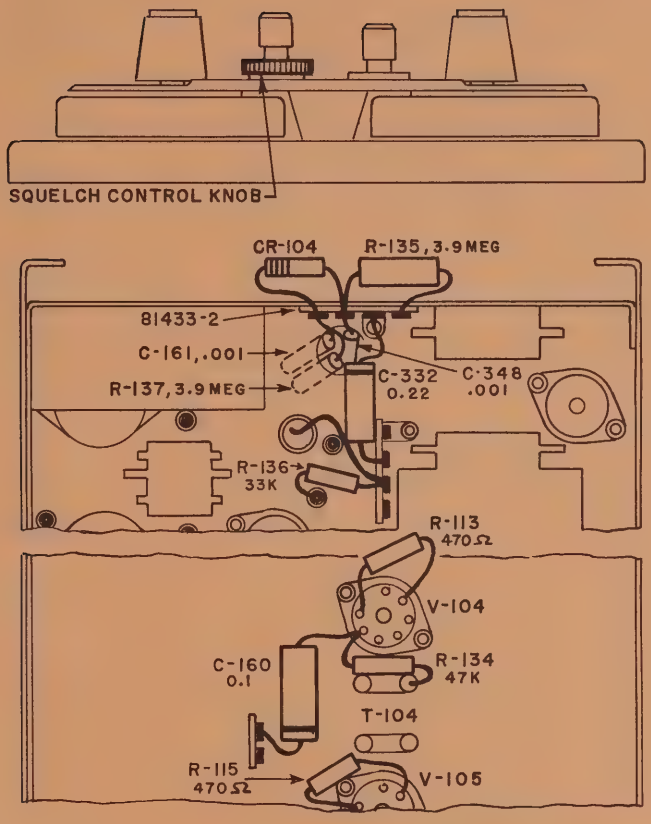


PHOTO Aa.
NARCO MARK-12, PANEL UNIT, Front View
CN-89 and CNP-89



TOP VIEW
SUPPLEMENT No. 1, for PHOTOS B and C,
pages 36 and 37.



BOTTOM VIEW
SUPPLEMENT No. 1, for PHOTOS D and E.
pages 38 and 39.

SECTION 7
REPLACEMENT PARTS

7-A. INTRODUCTION.

Provided, herewith, is a supplementary "List of Replacement parts ". It was prepared primarily to provide for parts added in Mark-12 Panel Units having Chassis No. CN-89-B and CNP-89-B.

This list also contains some corrections or additions to the original "7-B. LIST of PARTS" in MM-211, pages 43 thru 54.

Where no part number appears in this list, the number given in the original list applies.

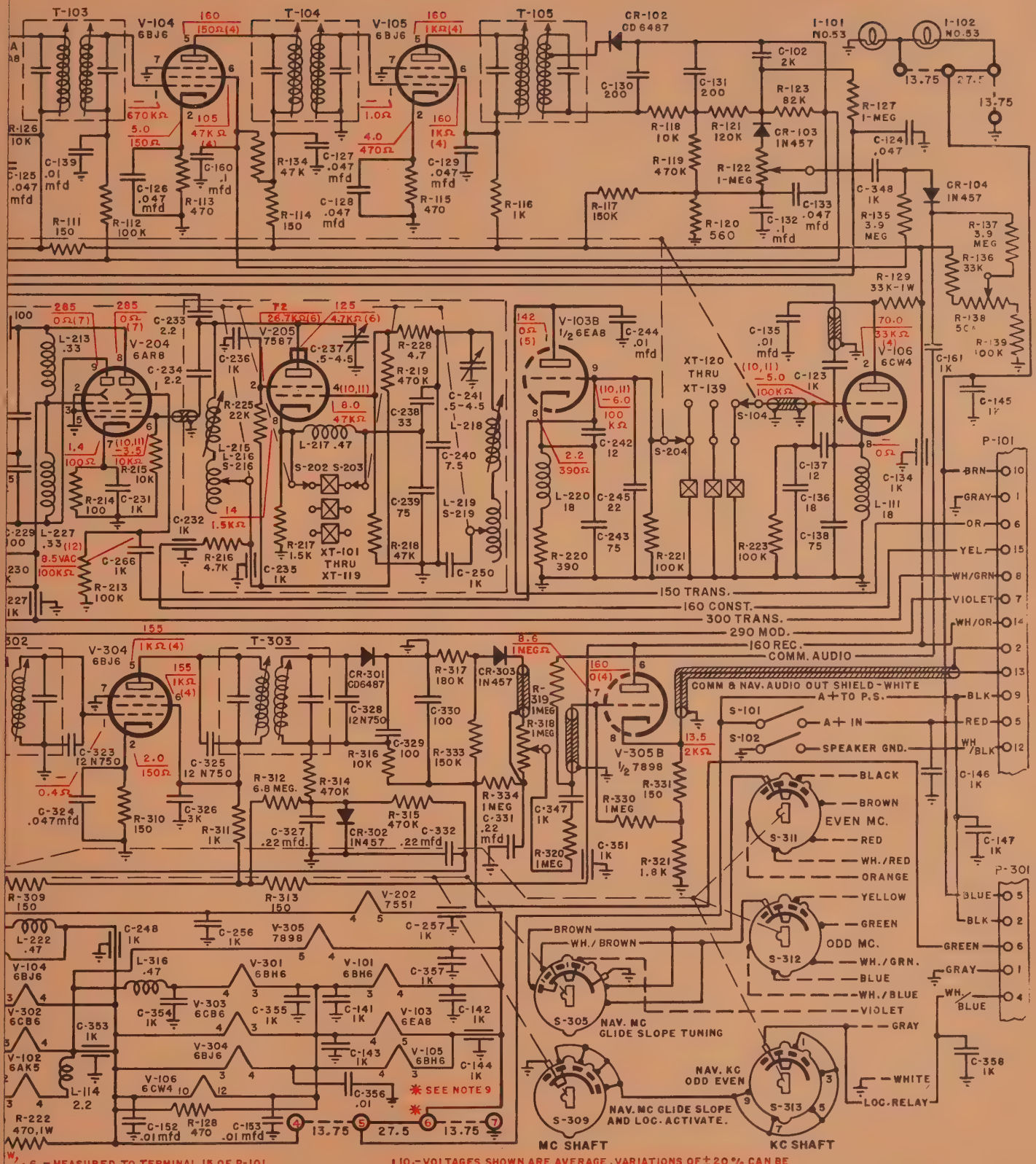
The items in this list marked with an asterisk (*) are corrections or additions for the original list.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-137*	24049-120	Dipped Mica, 500V, 12 micromicrofarads ±1.0 micromicrofarads	
C-160	23085-125	Mylar, 200V, 0.1 μfd, ±20%	CN-89-B, CNP-89-B
C-161	23085-151	Mylar, Tubular, 200V, .001 mfd, ±10%	CN-89-B, CNP-89-B
C-301	21201-100	Same as C-253	Early Production
C-301	21201-829	Ceramic Tub., 500V., 8.2μμf, ±0.5μμf	Later Production
C-348	21291-21	Same as C-106	CN-89-A, CNP-89-A
C-348	23085-151	Same as C-161	CN-89-B, CNP-89-B
		CR, DIODES	
CR-101*	75013-5	Diode, Silicon, CN12227 (Similar to 1N459)	CN-89-A, CNP-89-A CN-89-B, CNP-89-B
CR-102	75019-1	Diode, Silicon, IN914	CN-89-A, CNP-89-A CN-89-B, CNP-89-B Early Production
CR-102	75019-2	Diode, Silicon, CD6487	CN-89-A, CNP-89-A CN-89-B, CNP-89-B Later Production
CR-103*	75013-4	Diode, Silicon, CD12226 (Similar to 1N457)	CN-89-A, CNP-89-A CN-89-B, CNP-89-B
CR-104	74013-4	Same as CR-103	CN-89-B, CNP-89-B
		Q, TRANSISTORS	
Q-401	75510-2	Transistor, Driver	Early Production
Q-401	75534-4	Transistor, Audio Driver	Later Production
Q-402	75510-4	Transistor, Audio Output	24V. Mod-Pwr Unit Early Production
Q-402	75534-3	Transistor, Audio Output	24 V. Mod-Pwr Unit Later Production
Q-403	75510-4	Same as Q-402	12V. Mod-Pwr Unit Early Production
Q-403	75534-3	Same as Q-402	12V. Mod-Pwr Unit Later Production
		R, RESISTORS	
R-113	31141-122	Carbon, 1/2W, 1.2K ohms, ±10%	CNP-89-A.
R-113	31141-471	Carbon, 1/2W ,470 ohms, ±10%	CN-89-A, CN-89-B, CNP-89-B.
R-115	31141-821	Same as R-107	CNP-89-A.
R-115	31141-471	Same as R-113 for CN-89-A, CN-89-B, CNP-89-B	CNP-89-A, CNP-89-B, CN-89-B.

* Indicates a correction or addition for the original Replacement Parts List.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
R-120	31141-102	Same as R-110	CN-89-A, CNP-89-A
R-120	31141-561	Carbon, 1/2W, 560 ohms, ±10%	CN-89-B, CNP-89-B
R-122	32040-1	Potentiometer, 1/2W, 1 Megohm	CN-89-A, CNP-89-A, Volume Control
R-122	32033-1	Potentiometer, 1/2W, 1 Megohm	CN-89-B, CNP-89-B, Volume Control
R-133	31141-222	Carbon, 1/2W, 2.2K ohms, ±10%	CNP-89-A
R-134	31141-473	Same as R-102	CN-89-B, CNP-89-B
R-135	31141-395	Carbon, 1/2W, 3.9 Megohms, ±10%	CN-89-B, CNP-89-B
R-136	31149-333	Carbon, 1/2W, 33K ohms, ±5%	CN-89-B, CNP-89-B
R-137	31141-395	Same as R-135	CN-89-B, CNP-89-B
R-138	32033-1	Part of R-122 Assembly, Pot. 50K ohms	CN-89-B, CNP-89-B Squelch Control
R-139	31149-104	Carbon, 1/2W, 100K ohms, ±5%	CN-89-B, CNP-89-B
R-402	31141-681	Carbon, 1/2W, 680 ohms, ±10%	Early Production
R-402	31141-471	Same as R-113 for CN-89A, CN-89-B, CNP-89-B	Later Production
R-407*	31141-221	Same as R-103,	24 Volt Unit
R-408*	31141-822	Carbon, 1/2W, 8.2K ohms, ±10%	
		S, SWITCHES	
S-101	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A +DC On-Off
S-101	32033-1	Switch, Part of Assembly R-122	CN-89-B, CNP-89-B +DC On-Off
S-102	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A Speaker Ground
S-102	32033-1	Switch, Part of Assembly R-122	CN-89-B, CNP-89-B Speaker Ground
		T, TRANSFORMERS	
T-401*	11821-102	Transformer, Driver	12 and 24V Units
T-402*	11821-101	Transformer, Audio Output	12 Volt Units
T-402*	11633-101	Transformer, Audio Output	24 Volt Units
		XT, CRYSTALS, QUARTZ, SUBMINIATURE	
XT-121*	72007-141	9.425 Mc, for .05 Fractional Mc	COM Transceiver
XT-122*	72007-142	9.375 Mc, for .10 Fractional Mc	COM Transceiver
XT-123*	72007-143	9.325 Mc, for .15 Fractional Mc	COM Transceiver
XT-124*	72007-144	9.275 Mc, for .20 Fractional Mc	COM Transceiver
XT-125*	72007-145	9.225 Mc, for .25 Fractional Mc	COM Transceiver
		MISCELLANEOUS (No Symbol)	
None*	61404-101	Assembly, Detent Roller	COM. Kc
None*	66507-1	Fuse Holder	MOD-PWR Unit
None*	81330-3	Washer, Shoulder	For Mod-PWR Unit Q-401.
None*	81622-3	Clip, Tube Pin Type	For Mod-Pwer Unit Q-401, Q-402, & Q-403.
None	88148-2	Knob	Squelch Control

* Indicates a correction or addition for the original Replacement Parts List.



6.-MEASURED TO TERMINAL 15 OF P-101.
7.-MEASURED TO TERMINAL 8 OF P-101.
8.-MEASURED TO TERMINAL 7 OF P-101.
9.-TERMINALS 4,5,6, AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS. VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.

10.-VOLTAGES SHOWN ARE AVERAGE. VARIATIONS OF ±20% CAN BE EXPECTED.
11.-MEASURED THRU A 1 MEG-OHM RESISTOR.
12.-MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10 MC) VOLTMETER.
13.-VOLTAGE SHOWN ABOVE LINE - EXAMPLE VOLTAGE / RESISTANCE

Figure 11a.
SCHEMATIC, *narco* Mark-12, PANEL UNIT
For CN-89-B and CNP-89-B
T-02177A-Rev. V

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
R-120	31141-102	Same as R-110	CN-89-A, CNP-89-A
R-120	31141-561	Carbon, 1/2W, 560 ohms, ±10%	CN-89-B, CNP-89-B
R-122	32040-1	Potentiometer, 1/2W, 1 Megohm	CN-89-A, CNP-89-A, Volume Control
R-122	32033-1	Potentiometer, 1/2W, 1 Megohm	CN-89-B, CNP-89-B, Volume Control
R-133	31141-222	Carbon, 1/2W, 2.2K ohms, ±10%	CNP-89-A
R-134	31141-473	Same as R-102	CN-89-B, CNP-89-B
R-135	31141-395	Carbon, 1/2W, 3.9 Megohms, ±10%	CN-89-B, CNP-89-B
R-136	31149-333	Carbon, 1/2W, 33K ohms, ±5%	CN-89-B, CNP-89-B
R-137	31141-395	Same as R-135	CN-89-B, CNP-89-B
R-138	32033-1	Part of R-122 Assembly, Pot. 50K ohms	CN-89-B, CNP-89-B Squelch Control
R-139	31149-104	Carbon, 1/2W, 100K ohms, ±5%	CN-89-B, CNP-89-B
R-402	31141-681	Carbon, 1/2W, 680 ohms, ±10%	Early Production
R-402	31141-471	Same as R-113 for CN-89A, CN-89-B, CNP-89-B	Later Production
R-407*	31141-221	Same as R-103,	24 Volt Unit
R-408*	31141-822	Carbon, 1/2W, 8.2K ohms, ±10%	
		S, SWITCHES	
S-101	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A +DC On-Off
S-101	32033-1	Switch, Part of Assembly R-122	CN-89-B, CNP-89-B +DC On-Off
S-102	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A Speaker Ground
S-102	32033-1	Switch, Part of Assembly R-122	CN-89-B, CNP-89-B Speaker Ground
		T, TRANSFORMERS	
T-401*	11821-102	Transformer, Driver	12 and 24V Units
T-402*	11821-101	Transformer, Audio Output	12 Volt Units
T-402*	11633-101	Transformer, Audio Output	24 Volt Units
		XT, CRYSTALS, QUARTZ, SUBMINIATURE	
XT-121*	72007-141	9.425 Mc, for .05 Fractional Mc	COM Transceiver
XT-122*	72007-142	9.375 Mc, for .10 Fractional Mc	COM Transceiver
XT-123*	72007-143	9.325 Mc, for .15 Fractional Mc	COM Transceiver
XT-124*	72007-144	9.275 Mc, for .20 Fractional Mc	COM Transceiver
XT-125*	72007-145	9.225 Mc, for .25 Fractional Mc	COM Transceiver
		MISCELLANEOUS (No Symbol)	
None*	61404-101	Assembly, Detent Roller	COM. Kc
None*	66507-1	Fuse Holder	MOD-PWR Unit
None*	81330-3	Washer, Shoulder	For Mod-PWR Unit Q-401.
None*	81622-3	Clip, Tube Pin Type	For Mod-Pwer Unit Q-401, Q-402, & Q-403.
None	88148-2	Knob	Squelch Control

* Indicates a correction or addition for the original Replacement Parts List.

8-A. INTRODUCTION.

This schematic is similar to Figure 11, page 55, but it represents the later production Panel Units having the Chassis Number CN-89-B or CNP-89-B. These Units have the Squelch Control Associated with the COM Receiver.

Correction:

The Schematics, Figures 12 and 13, pages 56 and 57, for the 12 Volt and 24 Volt versions of the MP-12 Modulator-Power Units respectively, have only one change affecting the current production Units. The bias resistor, R-402, for the base of the Audio input transistor Q-401 has been changed from 680 ohms to 470 ohms, to improve modulation.

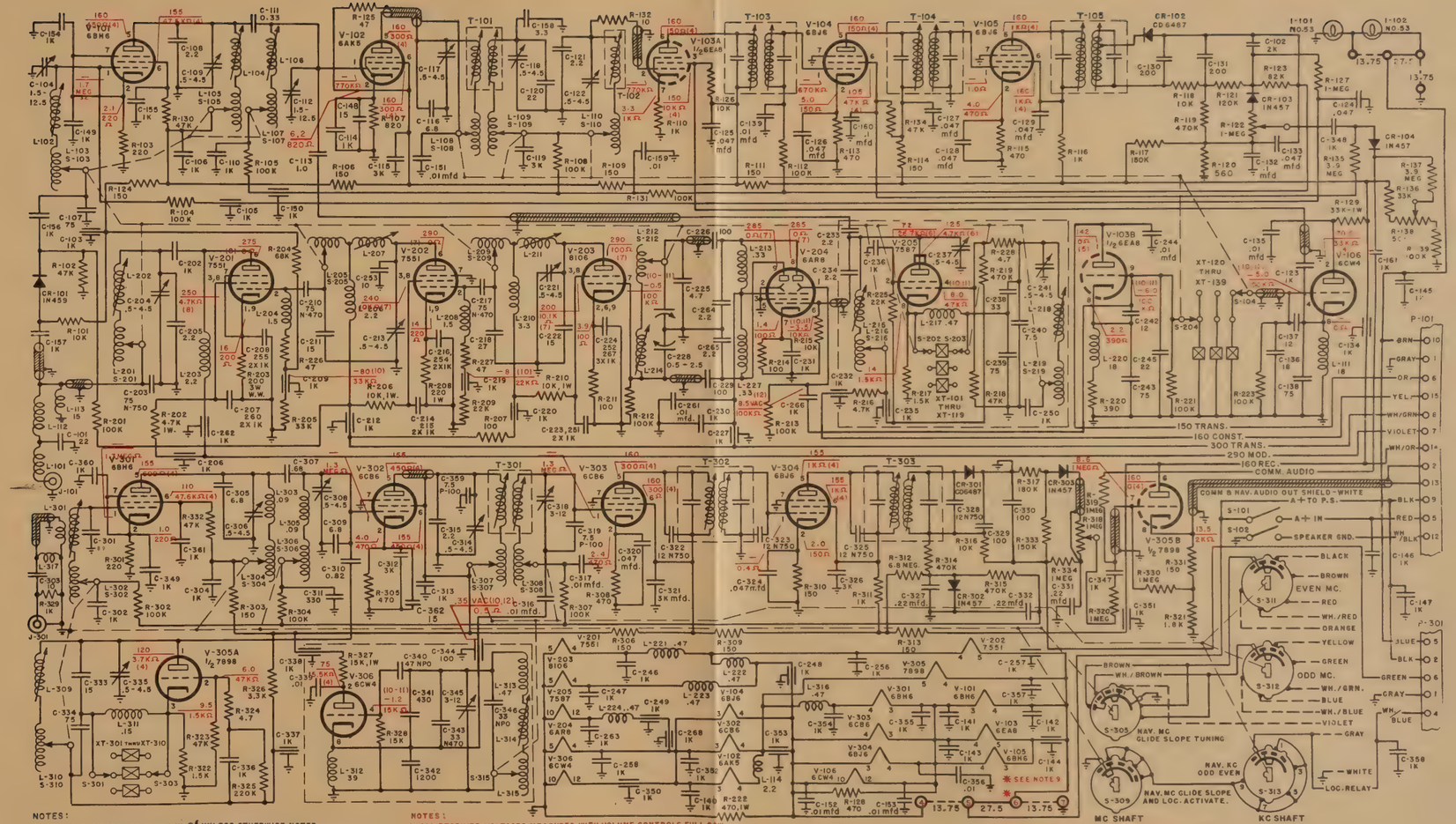

NOTES:
A.- ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
B.- ALL INDUCTORS ARE SHOWN IN MICRO-HENRIES UNLESS OTHERWISE NOTED.
C.- ALL RESISTORS ARE SHOWN IN ONE-HALF WATT UNLESS OTHERWISE NOTED.
D.- "K" DENOTES ONE THOUSAND. "M" DENOTES ONE MILLION.
NOTES:
1.- ALL RECEIVER VOLTAGES MEASURED WITH VOLUME CONTROLS FULL CW, SQUELCH CONTROL FULL CW, NO SIGNAL INPUT AND 13.75 V. DC APPLIED TO UNIT.
2.- ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V DC APPLIED TO UNIT.
3.- ALL RESISTANCES MEASURED TO CHASSIS (GND.) UNLESS OTHERWISE NOTED.
4.- MEASURED TO TERMINAL 14 OF P-101.
5.- MEASURED TO TERMINAL 6 OF P-101.
6.- MEASURED TO TERMINAL 15 OF P-101.
7.- MEASURED TO TERMINAL 8 OF P-101.
8.- MEASURED TO TERMINAL 7 OF P-101.
9.- TERMINALS 4, 5, 6, AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS. VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.
10.- VOLTAGES SHOWN ARE AVERAGE. VARIATIONS OF ±20% CAN BE EXPECTED.
11.- MEASURED THRU A 1 MEG. OHM RESISTOR.
12.- MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10 MC) VOLTMETER.
13.- VOLTAGE SHOWN ABOVE LINE - EXAMPLE VOLTAGE / RESISTANCE
MC SHAFT
KC SHAFT
NAV. MC GLIDE SLOPE TUNING
NAV. KC ODD EVEN
NAV. MC GLIDE SLOPE AND LOC. ACTIVATE.
ODD MC.
EVEN MC.
SPEAKER GND.
A+ IN
A+ TO P.S.
COMM. AUDIO
150 TRANS.
160 CONST.
300 TRANS.
290 MOD.
160 REC.
LOC. RELAY

Figure 11a.
SCHEMATIC, *narco* Mark-12, PANEL UNIT
For CN-89-B and CNP-89-B
T-02177A-Rev. V

NOTE—This sheet may be placed at the front of the original Manual MM-211, with its Supplement No. 1.

MARK-12
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL

for

CN89-A and CNP89-A Panel Units with
CNPA89-A and CNPB89-A Modulator-Power Units

With SUPPLEMENT No. 1, for CN89-B and CNP89-B Panel Units

And with SUPPLEMENT No. 2, for CN89-C & D and CNP89-C & D Panel Units, and for CNPA89-B and CNPB89-B Modulator-Power Units

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A. 3075-600 May, 1964

Supplement No. 2

For CN89-C & D and CNP89-C & D

also CNPA89-B and CNPB89-B

MARK-12
VHF Transceiver

with
NAVIGATION RECEIVER
and
T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL
SUPPLEMENT No. 2.

for
CN89-C & D and CNP89-C & D Panel Units,
and
CNPA89-B and CNPB89-B Modulator-Power Units

NOTE:

This Supplement No. 2 provides revised schematics representing current production. The differences are of a minor nature, based on developments during successive production runs and on field experience.

A block diagram is provided for use with the Circuit Description and Maintenance Sections.

A complete new Replacement Parts List is provided.

Corrections:

Page 15, Column 2, under 4-D, paragraph 2, read: ..... 105.55 Mc. ..... and ..... *first* mixer, V-303.

Page 21, column 1, under 5-D,3.

Procedure:

In paragraph f., the second sentence should read "This voltage measured on *Pin 1*, V-204, should be approximately 8.5 volts RMS.

Page 36, Photo B, near the lower right side, the call-out L-306/C-306 should read L-306/*S-306*.

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A. 3075-600 May, 1964

REPLACEMENT PARTS

NOTE:

This Supplement No. 2, Replacement Parts List is a complete integrated list for all Panel Units (CN89-A thru D and CNP89-A thru D) and all Modulator-Power Units (CNPA89-A & B and CNPB89 A & B).

A. INTRODUCTION.

This list of Replacement Parts contains the items that may be considered replaceable in the field. They should preferably be ordered by Symbol No., Part No., and Description.

The Replacement Parts are listed by their Symbol letter and number, alphabetically then numerically. Some items without a Symbol No., are listed numerically by Part Number in a "Miscellaneous" List following the listings by Symbol numbers. A few items without a Symbol No. may be listed with associatd parts such as connectors.

The "Function or Application" column is intended to separate the description of the item from its purpose in the equipment. It may also be found useful when working with the Illustrations and Schematics.

B. LIST OF PARTS.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-101	21201-220	Ceramic Tubular, 500V, 22 micromicrofarads, ±10%	
C-102	21291-15	Ceramic Disc, 500V, .002 microfarads, ± 10%	
C-103	21298-1	Feed-Thru, 500V, .001 microfarad, + 100% − 0%	
C-104	22019-2	Variable Plunger, 500V, 1.5 − 12.5 micromicrofarads	
C-105	21298-1	Same as C-103	COM RCVR RF Input
C-106	21291-21	Ceramic Disc., 1000V., .001 microfarad, ± 20%	
C-107	21384-750	Ceramic Tubular, 500V, 75 micromicrofarads, ± 5%	
C-108	24516-229	Ceramic Disc., 500V, 2.2 micromicrofarads, ± 0.25	
C-109	22019-1	Variable Plunger, 500V, 0.5 − 4.5 micromicrofarads	COM RCVR RF Output
C-110	21291-21	Same as C-106	
C-111	24509-338	Ceramic, 500V., .33 micromicrofarads, ± 5%	
C-112	22019-2	Same as C-104	
C-113	24502-109	Ceramic, 500V., 1.0 micromicrofarads, ± 5%	COM RCVR First Mixer Input
C-114	21291-21	Same as C-106	
C-115	21291-4	Ceramic Disc, 500V, .003 microfarad, ± 80% − 20%	
C-116	24516-689	Ceramic Disc, 500V., 6.8 micromicrofarads ± 0.5 micromicrofarads	
C-117	22019-1	Same as C-109	COM RCVR First Mixer Output
C-118	22019-1	Same as C-109	COM RCVR HF IF
C-119	21291-9	Ceramic Disc, 500V., .003 microfarad, ± 10%	
C-120	21201-220	Same as C-101	
C-121	24516-229	Same as C-108	
C-122	22019-1	Same as C-109	COM RCVR Second Mixer Input
C-123	21291-21	Same as C-106	
C-124	23085-71	Mylar, 100V., .047 microfarad, ± 10%	
C-125	23085-171	Mylar, 200V., .047 microfarad, ± 10%	
C-126	23085-71	Same as C-124	
C-127	23085-171	Same as C-125	
C-128	23085-71	Same as C-124	
C-129	23085-171	Same as C-125	
C-130	21291-11	Ceramic Disc, 500V., 200 micromicrofarads, ± 10%	
C-131	21291-11	Same as C-130	
C-132	23085-75	Mylar, 100V, 0.1 microfarad, ± 10%	
C-133	23085-71	Same as C-124	
C-134	21298-1	Same as C-103	
C-135	21291-6	Ceramic Disc, 500V., 0.01 microfarad, GMV	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS, (Continued)	
C-136	24049-180	Dipped Mica, 500V., 18 micromicrofarads, ±5%	
C-137	24049-120	Dipped Mica, 500V., 12 micromicrofarads, ±1.0 micromicrofarads	
C-138	24049-750	Dipped Mica, 500 V., 75 micromicrofarads, ±5%	
C-139	23085-113	Mylar, 200V., .01 microfarad, ±20%	
C-140	21291-21	Same as C-106	
C-141	21291-21	Same as C-106	
C-142	21291-21	Same as C-106	
C-143	21291-21	Same as C-106	
C-144	21298-1	Same as C-103	
C-145	21291-21	Same as C-106	
C-146	21291-21	Same as C-106	
C-147	21291-21	Same as C-106	
C-148	24516-150	Ceramic Disc, 15 micromicrofarads, ±10%	
C-149	21291-21	Same as C-106	
C-150	21298-1	Same as C-103	
C-151	21291-6	Same as C-135	
C-152	21291-5	Ceramic Disc, 50 V., .01 mf, +80% −30%	
C-153	21291-5	Same as C-152	
C-154	21291-21	Same as C-106	
C-155	21291-21	Same as C-106	
C-156	21291-21	Same as C-106	
C-157	21291-21	Same as C-106	
C-158	24516-339	Ceramic Disc, 500V., 3.3 micromicrofarads, ±10%	
C-159	23085-113	Same as C-139	
C-160	23085-125	Mylar, 200V, 0.1 μfd, ±20%	CN-89-B,-C,-D. CNP-89-B,-C,-D
C-161	23085-151	Mylar, Tubular, 200V, .001 mfd, ±10%	CN-89-B,-C,-D CNP-89-B,-C, -D.
C-201	21201-220	Same as C-101	CN-89-C,-D. CNP-89-C,-D.
C-202	21291-21	Same as C-106	
C-203	21384-750	Same as C-107	
C-204	22019-1	Same as C-109	XMTR PA Output
C-205	21201-229	Ceramic Tubular, 500V, 2.2 micromicrofarads, 0.25 micromicrofarads	
C-206	21298-1	Same as C-103	
C-207	21291-21	Same as C-106	
C-208	21291-21	Same as C-106	
C-209	21298-1	Same as C-103	
C-210	21383-750	Ceramic Tub., 500V., 75 micromicrofarads, ±5%	
C-211	21201-150	Ceramic Tub., 500V., 15 mmf, ±10%	
C-212	21298-1	Same as C-103	
C-213	22019-1	Same as C-109	XMTR Buffer Output
C-214	21291-21	Same as C-106	
C-215	21291-21	Same as C-106	
C-216	21291-21	Same as C-106	
C-217	21383-750	Same as C-210	
C-218	21201-270	Ceramic Tub., 500V., 27 mmf, ±10%	
C-219	21298-1	Same as C-103	
C-220	21298-1	Same as C-103	
C-221	22019-1	Same as C-109	XMTR RF Amp. Output
C-222	21201-150	Same as C-211	
C-223	21291-21	Same as C-106	
C-224	21291-21	Same as C-106	
C-225	21201-479	Ceramic Tub., 500 V., 4.7 mmf, ±0.5 micromicrofarads	
C-226	21291-14	Ceramic Disc, 500V., 100 mmf, ±10%	
C-227	21298-1	Same as C-103	
C-228	22029-1	Split Stator Glass, 500V., 0.5 to 2.5 micromicrofarads	XMTR Mixer
C-229	21291-14	Same as C-226	
C-230	21291-21	Same as C-106	
C-231	21291-21	Same as C-106	
C-232	21298-1	Same as C-103	
C-233	24516-229	Same as C-108	
C-234	24516-229	Same as C-108	
C-235	21298-1	Same as C-103	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS, (Continued)	
C-236	21291-21	Same as C-106	
C-237	22019-1	Same as C-109	COM TCVR HFO/Doubler Output
C-238	24049-330	Dipped Mica, 500V., 33 micromicrofarads, ±5%	
C-239	24049-750	Same as C-138	
C-240	21201-759	Ceramic Tub., 500V., 7.5 micro microfarads, ±0.5 micromicrofarad	
C-241	22019-1	Same as C-109	COM TCVR HFO/Doubler Input
C-242	24049-120	Same as C-137	
C-243	24049-750	Same as C-138	
C-244	21291-6	Same as C-135	
C-245	24049-220	Dipped Mica, 500V., 22 micromicrofarads, ±5%	
C-246	21291-21	Same as C-106	
C-247	21291-21	Same as C-106	
C-248	21298-1	Same as C-103	
C-249	21298-1	Same as C-103	
C-250	21291-19	Ceramic Disc, 500V., 1K micromicrofarad, ±10%	
C-251	21291-21	Same as C-106	
C-252	21291-21	Same as C-106	
C-253	21201-100	Ceramic Tub., 500 V., 10 micromicrofarads, ±1.0 micromicrofarads	
C-254	21291-21	Same as C-106	
C-255	21291-21	Same as C-106	
C-256	21291-21	Same as C-106	
C-257	21298-1	Same as C-103	
C-258	21291-21	Same as C-106	
C-259		Not Used	
C-260	21291-21	Same as C-106	
C-261	21291-6	Same as C-135	
C-262	21298-1	Same as C-103	
C-263	21291-21	Same as C-106	
C-264	24516-229	Same as C-108	
C-265	24516-229	Same as C-108	
C-266	21291-21	Same as C-106	CN-89-A,-B, CNP-89-A,-B.
C-266	21291-5	Same as C-152	CN-89-C,-D CNP-89-C,-D.
C-267	21291-21	Same as C-106	
C-268	21298-1	Same as C-103	
C-301	21201-100	Same as C-253	Early Production
C-301	21201-829	Ceramic Tub., 500V., 8.2μμf, ±0.5μμf, NPO.	Later Production
C-302	21291-21	Same as C-106	
C-303	21201-100	Same as C-253	
C-304	21291-21	Same As C-106	
C-305	24516-689	Same as C-116	
C-306	22019-1	Same as C-109	NAV RCVR RF Output
C-307	24509-688	Ceramic, 500V., 68 micromicrofarads, ±5%	
C-308	22019-1	Same as C-109	NAV RCVR First Mixer Input
C-309	24516-689	Same as C-116	
C-310	24509-828	Ceramic, 500V., .82 micromicrofarads, ±5%	
C-311	21219-18	Ceramic Disc. 500V., 330 micromicrofarads, ±10%	
C-312	21291-4	Same as C-115	
C-313	21291-21	Same as C-106	
C-314	22019-1	Same as C-109	NAV RCVR First Mixer Output
C-315	21201-229	Same as C-205	
C-316	21291-6	Same as C-135	
C-317	23085-113	Same as C-139	
C-318	22001-312	Ceramic Trimmer, 350V., 3-12 mmf, NPO	NAV Second Mixer Input
C-319	21282-2	Ceramic Tub., 500V., 7.5 micromicrofarads, ±0.5%	
C-320	23085-71	Same as C-124	
C-321	21291-4	Same as C-115	
C-322	21207-120	Ceramic Tub., 12 micromicrofarads, ±10%, N-750	
C-323	21207-120	Same as C-322	
C-324	23085-71	Same as C-124	
C-325	21207-120	Same as C-322	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS (Continued)	
C-326	21291-4	Same as C-115	
C-327	23085-79	Mylar, 100V., 22 microfarad, ±10%	
C-328	21207-120	Same as C-322	
C-329	21291-14	Same as C-226	
C-330	21291-14	Same as C-226	
C-331	23085-79	Same as C-327	
C-332	23085-79	Same as C-327	
C-333	24049-150	Dipped Mica, 500 V., 15 micromicrofarads, ±1.0 micromicrofarad	
C-334	24049-750	Same as C-327	
C-335	22019-1	Same as C-109	NAV RCVR HFO Output
C-336	21291-21	Same as C-106	
C-337	21298-1	Same as C-103	
C-338	21298-1	Same as C-103	
C-339	21291-6	Same as C-135	
C-340	21299-470	Ceramic Tub., 500V., 47 micromicrofarads, ±10%	
C-341	24049-431	**Dipped Mica, 500V., 430 micromicrofarads, ±5% micromicrofarad**	
C-342	24045-122	Dipped Mica, 500V., 1200 micromicrofarads	
C-343	21206- 330	Ceramic Tub., 500V., 33 μμf, ±10%, N-470	CN-89-A,-B CNP-89-A,-B
C-343	21294-330	Ceramic Tub., 500V., 33μμf, ±10% N-1500	CN-89-C,-D CNP-89-C,-D
C-344	24517-1	Feed Thru, 500V., 100 micromicrofarads, ±10%	
C-345	22001-312	Same as C-318	
C-346	21201-330	Ceramic Tub., 500 V., 33μμf, ±10%	
C-346	21201-Sel.	Ceramic Tub., 500V., 33 or 47 micromicrofarads, ±10%	
C-347	21291-21	Same as C-106	
C-348	21291-21	Same as C-106	CN-89-A CNP-89-A
C-348	23085-151	Same as C-161	CN-89-B,-C,-D CNP-89-B,-C,-D
C-349	21291-21	Same as C-106	
C-350	21298-1	Same as C-103	
C-351	21298-1	Same as C-103	
C-352	21291-21	Same as C-106	
C-353	21298-1	Same as C-103	
C-354	21291-21	Same as C-106	
C-355	21291-21	Same as C-106	
C-356	21291-5	Same as C-152	
C-357	21291-21	Same as C-106	
C-358	21291-21	Same as C-106	
C-359	21282-2	Same as C-319	
C-360	21291-21	Same as C-106	
C-361	21291-21	Same as C-106	
C-362	24516-150	Same as C-148	
C-363	21291-7	Ceramic Disc, 1000V., 470μμf, ±20%	CN-89-C,-D CNP-89-C,-D
C-364	21291-21	Same as C-106	CN-89-C,-D CNP-89-C,-D
C-401	21552-16	Electrolytic, 3V., 150 microfarads, +150% −10%	
C-402	21552-17	Electrolytic, 15V., 500 microfarads, Min. Tol.	
C-403	23085-113	Same as C-139	
C-404	21552-3	Electrolytic, 35V., 20 mf, +150% −10%	
C-405	21291-22	Ceramic Disc, 500V., .005 mf, ±10%	
C-406	21552-18	Electrolytic, 15 forward, 5 reverse, 30 mfd, +150% −10%	
C-501	23085-25	Mylar, 100V., 0.1μf, ±20%	
C-502	21525-23	Electrolytic, 400V., −50 mf, 200V. −100 mf, 200V. −20 mf	
C-503	21291-23	Ceramic Disc, 500V., .004 mf, ±10%	24 V. Operation
C-503	21291-22	Same as C-405	12 V. Operation
C-504	21291-22	Same as C-503	12 V. Operation
C-504	21291-23	Same as C-503	24 V. Operation
C-505	23085-87	Mylar, 100V., 1.0 mf, ±10%	
C-506	21525-25	Electrolytic, 35V., 500 mf	
C-507	23085-25	Same as C-501	CNPA-89-B CNPB-89-B
C-508	23085-25	Same as C-501	CNPA-89-B CNPB-89-B

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		CR, DIODES	
CR-101	75013-5	Diode, Silicon, CD12227 (Similar to 1N459)	CN-89-A,-B,-C,-D CNP-89-A,-B,-C,-D
CR-102	75019-1	Diode, Silicon, 1N914	CN-89-A, CNP-89-A CN-89-B CNP-89-B Early Production
CR-102	75019-2	Diode, Silicon, CD6487	CN-89-A, CNP-89-A CN-89-B, CNP-89-B Later Production
CR-103	75013-4	Diode, Silicon, CD12226 (Similar to 1N457)	CN-89-A,-B,-C,-D CNP-89-A,-B,-C,-D
CR-104	74013-4	Same as CR-103	CN-89-B,-C,-D CNP-89-B,-C,-D
CR-201	75019-2	Same as CR-102	Later Production
CR-301	75019-1	Same as CR-102	NAV RCVR
CR-302	75013-4	Same as CR-103	NAV RCVR
CR-303	75013-4	Same as CR-103	NAV RCVR
CR-501	75204-5	Diode, Silicon, 500 PIV	MOD-PWR Unit
CR-502	75204-5	Same as CR-501	MOD-PWR Unit
CR-503	75204-5	Same as CR-501	MOD-PWR Unit
CR-504	75204-5	Same as CR-501	MOD-PWR Unit
CR-505	75204-5	Same as CR-501	MOD-PWR Unit
CR-506	75204-5	Same as CR-501	MOD-PWR Unit
		F, FUSES	
F-501	66504-12	Fuse, 10A, Slow-Acting Type	12V. MOD-PWR Unit
F-501	66504-10	Fuse, 6-1/4A, Slow-Acting Type	24V. MOD-PWR Unit
		I, LAMPS	
I-101		Lamp No. 53 Red	Panel Illumination
I-102		Lamp, Same as I-101	Panel Illumination
		J, JACKS (CONNECTORS)	
J-101	41110-2	Connector, Chassis, Female	Com. Ant., Panel Unit
J-301	41143-1	Connector, Chassis, Female	Nav. Ant., Panel Unit
J-501	41181-4	Connector, 16 Pin	Power, MP Unit
		K, RELAYS	
K-501	65126-20	Relay, 5 Form C Contacts	T-R Transfer MOD-PWR Unit
		L, INDUCTORS	
L-101	11135-9	Choke	RF Antenna Filter
L-102	11273-26	Coil, Ant. Com. Rec.	
L-103	61378-101	Step Inductor	
L-104	11412-123	Coil, RF Plate, Com.	
L-105	61378-101	Same as L-103	
L-106	11412-129	Coil, Mixer, Comm.	
L-107	61378-101	Same as L-103	
L-108	61406-1	Step Inductor	HF IF COM
L-109	61406-1	Same as L-108	
L-110	61406-1	Same as L-108	
L-111	11138-22	Choke, RF, 18 microhenries, ±10%	
L-112	11135-9	Same as L-101	
L-113	11138-19	Choke, RF, 15 microhenries, ±10%, Insulated	
L-114	11138-9	Choke, RF, 2.2 microhenries	
L-201	61378-101	Same as L-103	
L-202	11627-1	Coil, Final Tank	
L-203	11138-9	Same as L-114	
L-204	11138-8	Choke, RF, 1.5 microhenry, ±20%	
L-205	61378-101	Same as L-103	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		L, INDUCTORS (CONTINUED)	
L-206	11138-9	Same as L-203	
L-207	11412-133	Coil, Second Buffer	
L-208	11138-8	Same as L-204	
L-209	61378-101	Same as L-103	
L-210	11138-11	Choke, RF, 3.3 microhenries, ±10%	
L-211	11412-134	Coil, First Buffer	
L-212	61378-101	Same as L-103	
L-213	11138-4	Choke, RF, 0.33 microhenry, ±20%	
L-214	11412-135	Coil, Mixer	
L-215	11412-132	Coil, Doubler	
L-216	61393-101	Step Inductor Doubler	
L-217	11138-5	Choke, RF, 0.47 microhenry, ±10%	
L-218	11412-112	Coil, HFO	
L-219	61393-101	Same as L-216	
L-220	11138-22	Same as L-111	
L-221	11138-5	Same as L-217	
L-222	11138-5	Same as L-217	
L-223	11138-5	Same as L-217	
L-224	11138-5	Same as L-217	
L-225	11138-5	Same as L-217	CN-89-C,-D CNP-89-C,-D
L-226	11138-5	Same as L-217	CN-89-C,-D CNP-89-C,-D
L-227	11138-4	Same as L-213	
L-301	11273-22	Coil, RF	
L-302	61386-1	Step Inductor	
L-303	11138-27	Choke, RF, 0.09 microhenry, ±10%	
L-304	61386-1	Same as L-302	
L-305	11138-27	Same as L-303	
L-306	61386-1	Same as L-302	
L-307	61407-1	Step Inductor, HF IF	
L-308	61407-1	Same as L-307	
L-309	11412-131	Coil, HFO	
L-310	61386-1	Same as L-302	
L-311	11138-2	Choke, RF, 0.15 microhenry, ±20%	
L-312	11359-20	Choke, RF, 39 microhenries, ±10%	
L-313	11138-28	Choke, RF, 0.49 μh., ±5%	CN-89-A,-B CNP-89-A,-B
L-313	11138-5	Choke, RF, insulated, 0.47 μh, ±20%	CN-89-C,-D CNP-89-C,-D
L-314	11273-21	Coil, LFO	
L-315	61384-1	Step Inductor, LFO	
L-316	11138-5	Same as L-217	
L-317	11135-9	Same as L-101	
L-401	11814-2	Inductor, Filter	
L-501	11176-3	Choke, 50 microhenries	
		P, PLUGS (CONNECTORS)	
P-101	41181-3	Connector, 16 Pin Male	Power Circuits, Panel Unit Cable Assy.
	41182-2	Cap, Connector, for P-102 and P-501	Power Circuits, Panel Unit Cable Assy.
P-102	41271-1	Connector, 16 Pin Female	Panel to MP Unit Cable
P-301	41117-1	Connector, 6 Pin Female	Omni Circuits, Panel Unit Cable Assy.
	41130-1	Connector, Male	COM Ant.
	41237-1	Connector, Male	NAV Ant. Cable
	41237-2	Ferrule, for 41237-1	NAV Ant. Cable
P-501	41271-1	Same as P-102	Same as P-102
		Q, TRANSISTORS	
Q-401	75510-2	Transistor, Audio Driver	Early Production
Q-401	75534-4	Transistor, Audio Driver	Later Production
Q-402	75510-4	Transistor, Audio Output	24V. Mod-Pwr Unit Early Production

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
Q-402	75534-3	Transistor, Audio Output	24 V. Mod-Pwr Unit Later Production
Q-403	75510-4	Same as Q-402	12V. Mod-Pwr Unit Early Production
Q-403	75534-3	Same as Q-402	12V. Mod-Pwr Unit Later Production
Q-501	75504-1	Transistor, DC Power, 2N441	12V. Mod-Pwr Unit
Q-501	75505-3	Transistor, DC Power, 2N174	24 V. Mod-Pwr Unit
Q-502	75504-1	Same as Q-501	12V Mod-Pwr Unit
Q-502	75505-3	Same as Q-501	24 V. Mod-Pwr Unit
		R, RESISTORS	
R-101	31141-103	Carbon, ½ W, 10K ohms, ±10%	
R-102	31141-473	Carbon, ½ W, 47K ohms, ±10%	
R-103	31141-221	Carbon, ½ W, 220 ohms, ±10%	
R-104	31141-104	Carbon, ½ W, 100K ohms, ±10%	
R-105	31141-104	Same as R-104	
R-106	31141-151	Carbon, ½ W, 150 ohms, ±10%	
R-107	31141-821	Carbon, ½ W, 820 ohms, ±10%	
R-108	31141-104	Same as R-104	
R-109	31141-151	Same as R-106	
R-110	31141-102	Carbon, ½ W, 1K ohms, ±10%	
R-111	31141-151	Same as R-106	
R-112	31141-104	Same as R-104	
R-113	31141-122	Carbon, ½ W, 1.2K ohms, ±10%	CNP-89-A
R-113	31141-471	Carbon, ½ W, 470 ohms, ±10%	CN-89-A, CN-89-B-C-D CNP-89-B-C-D
R-114	31141-151	Same as R-106	
R-115	31141-821	Same as R-107	CNP-89-A
R-115	31141-471	Same as R-113 for CN-89, -A, CN-89-B, CNP-89-B.	CNP-89-A, CN-89-B,-C-D. CNP-89-B,-C,-D.
R-116	31141-102	Same as R-110	
R-117	31141-154	Carbon, ½ W, 150K ohms, ±10%	
R-118	31141-103	Same as R-101	
R-119	31141-474	Carbon, ½ W, 470K ohms ±10%	
R-120	31141-102	Same as R-110	CN-89-A, CNP-89-A
R-120	31141-561	Carbon, ½ W, 560 ohms, ±10%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-121	31141-124	Carbon, ½ W, 120 K ohms, ±10%	
R-122	32040-1	Potentiometer, ½ W, 1 Megohm	CN-89-A, CNP-89-A Volume Control
R-122	32033-1	Potentiometer, ½ W, 1 Megohm	CN-89-B,-C,-D CNP-89-B,-C,-D Volume Control
R-123	31141-823	Carbon, ½ W, 82K ohms, ±10%	
R-124	31141-151	Same as R-106	
R-125	31141-470	Carbon, ½ W, 47 ohms, ±10%	
R-126	31141-103	Same as R-101	
R-127	31141-105	Carbon, ½ W, 1 Megohm, ±10%	
R-128	31141-471	Same as R-305	
R-129	31135-333	Carbon, 1 W, 33 K ohms, ±10%	
R-130	31141-473	Same as R-102	
R-131	31141-104	Same as R-104	
R-132	31141-100	Carbon, ½ W, 10 ohms, ±10%	
R-133	31141-222	Carbon, ½ W, 2.2K ohms, ±10%	CNP-89-A
R-134	31141-473	Same as R-102	CN-89-B,-C,-D CNP-89-B,-C,-D
R-135	31141-395	Carbon, ½ W, 3.9 Megohms, ±10%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-136	31149-333	Carbon, ½ W, 33K ohms, ±5%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-137	31141-395	Same as R-135	CN-89-B,-C,-D CNP-89-B,-C,-D
R-138	32033-1	Part of R-122 Assembly, Pot. 50K ohms	CN-89-B,-C,-D CNP-89-B,-C,-D Squelch Control
R-139	31149-104	Carbon, ½ W, 100K ohms, ±5%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-201	31141-104	Same as R-104	
R-202	31135-472	Carbon, 1 W, 4.7K ohms, ±10%	
R-203	31161-8	Wire-wound, 3 W, 200 ohms, ±5%	
R-204	31141-683	Carbon, ½ W, 68K ohms, ±10%	
R-205	31141-333	Carbon, ½ W, 33K ohms, ±10%	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		R, RESISTORS (CONTINUED)	
R-206	31135-103	Carbon, 1 W, 10K ohms, ± 10%	
R-207	31141-101	Carbon, ½ W, 100 ohms, ± 10%	
R-208	31135-221	Carbon, 1 W, 220 ohms, ± 10%	
R-209	31141-223	Carbon, ½ W, 22K ohms, ± 10%	
R-210	31135-103	Same as R-206	
R-211	31141-101	Same as R-207	
R-212	31141-104	Same as R-104	
R-213	31141-104	Same as R-104	
R-214	31141-101	Same as R-207	
R-215	31141-103	Same as R-101	
R-216	31141-472	Carbon, ½ W, 4.7K ohms, ± 10%	
R-217	31141-152	Carbon, ½ W, 1.5K ohms, ± 10%	
R-218	31141-473	Same as R-102	
R-219	31141-474	Same as R-119	
R-220	31141-391	Carbon, ½ W, 390 ohms, ± 10%	
R-221	31141-104	Same as R-104	
R-222	31135-471	Carbon, 1 W, 470 ohms, ± 10%	
R-223	31141-104	Same as R-104	
R-224	31135-333	Same as R-129	CN-89-C,-D CNP-89-C,-D
R-225	31141-223	Same as R-209	
R-226	31141-470	Same as R-125	
R-227	31141-470	Same as R-125	
R-228	31141-479	Carbon, ½ W, 4.7 ohms, ± 10%	
R-301	31141-221	Same as R-103	
R-302	31141-104	Same as R-104	
R-303	31141-151	Same as R-106	
R-304	31141-104	Same as R-104	
R-305	31141-471	Carbon, ½ W, 470 ohms, ± 10%	
R-306	31141-151	Same as R-106	
R-307	31141-104	Same as R-104	
R-308	31141-471	Same as R-305	
R-309	31141-151	Same as R-106	
R-310	31141-141	Same as R-106	
R-311	31141-102	Same as R-110	
R-312	31141-685	Carbon, ½ W, 6.8 Megohms, ± 10%	
R-313	31141-151	Same as R-106	
R-314	31141-474	Same as R-119	
R-315	31141-474	Same as R-119	
R-316	31141-103	Same as R-101	
R-317	31141-184	Carbon, ½ W, 180K ohms, ± 10%	
R-318	32040-2	Potentiometer, ½ W, 1 Meg. ± 5%	Volume Control
R-319	31141-105	Same as R-127	
R-320	31141-105	Same as R-127	
R-321	31141-182	Carbon, ½ W, 1.8K ohms, ± 10%	
R-322	31141-152	Same as R-217	
R-323	31141-473	Same as R-102	
R-324	31141-479	Same as R-228	
R-325	31141-224	Carbon, ½ W, 220K ohms, ± 10%	
R-326	31141-332	Carbon, ½ W, 3.3K ohms, ± 10%	
R-327	31135-153	Carbon, 1 W, 15K ohms, ± 10%	
R-328	31141-153	Carbon, ½ W, 15K ohms, ± 10%	
R-329	31141-102	Same as R-110	
R-330	31141-105	Same as R-127	
R-331	31141-151	Same as R-106	
R-332	31141-473	Same as R-102	
R-333	31141-154	Same as R-117	
R-334	31141-105	Same as R-127	
R-401	31141-821	Same as R-107	
R-402	31141-681	Carbon, ½ W, 680 ohms, ± 10%	Early Production
R-402	31141-471	Same as R-113 for CN-89A, CN-89B, CNP-89-B	Later Production
R-403	31179-1	Temp. Sensitive, 0.47 ohm, ± 10% + TC	
R-404	31141-471	Same as R-113	

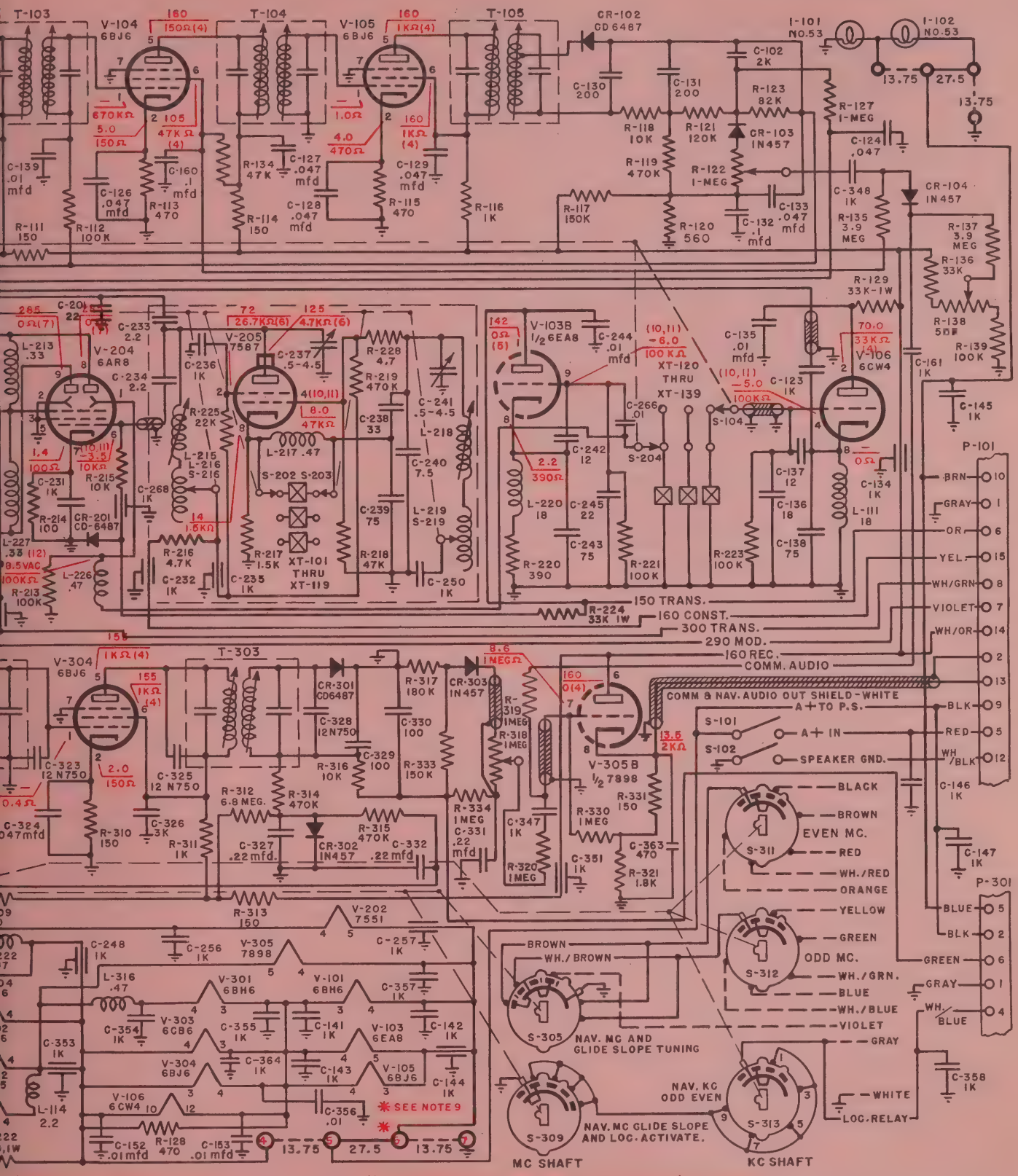
SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		R, RESISTORS (CONTINUED)	
R-405	31136-270	Carbon, 2W, 27 ohms, ±10%	
R-406	31135-221	Carbon, 1 W, 220 ohms, ±10%	12V. Unit
R-406	31135-681	Carbon, 1 W, 680 ohms, ±10%	24V. Unit
R-407	31141-151	Same as R-106	12V. Unit
R-407	31141-221	Same as R-103	24 Volt Unit
R-408	31141-822	Carbon, ½ W, 8.2K ohms, ±10%	
R-409	31175-11	Wirewound, 5W, 75 ohms, ±5%	
R-410	31141-331	Carbon, ½ W, 330 ohms, ±10%	CN-89-C,-D CNP-89-C,-D
R-501	31141-180	Carbon, ½ W, 18 ohm, ±10%	12V MOD-PWR Unit
R-501	31141-101	Same as R-207	24V MOD-PWR Unit
R-502	31136-331	Carbon, 2W, 330 ohm, ±10%	12V MOD-PWR Unit
R-502	31136-102	Carbon, 2W, 1K ohms, ±10%	24V MOD-PWR Unit
R-503	31136-331	Same as R-503	12V MOD-PWR Unit
R-503	31136-102	Same as R-502	24V MOD-PWR Unit
R-504	31141-180	Same as R-501	12V MOD-PWR Unit
R-504	31141-101	Same as R-501	24V MOD-PWR Unit
R-505	31135-274	Carbon, 1W, 270K ohms, ±10%	
R-506	31136-101	Carbon, 2W, 100 ohms, ± 10%	
R-507	31175-11	Same as R-409	
R-508	31141-220	Carbon, ½ W, 22 ohm, ±10%	For CN-89-A,-B CNP-89-A,-B
R-508	31141-330	Carbon, ½ W, 33 ohms, ±10%	For CN-89-C-D CNP-89-C-D
R-509	31141-220	Same as R-508 for CN-89-A,-B	
R-510	31141-220	Same as R-508 for CN-89-A,-B	
		S, SWITCHES	
S-101	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A +DC On-Off
S-101	32033-1	Switch, Part of Assembly R-122	CN-89-B,-C,-D CNP-89-B,-C,-D +DC On-Off
S-102	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A Speaker Ground
S-102	32033-1	Switch, Part of Assembly R-122	CN-89-B,-C,-D CNP-89-B,-C,-D Speaker Ground
S-103	61378-101	Switch, Part of L-103	COM RCVR RF Input
S-104	61409-101	Switch, Assembly	XTAL Sel., Kc
S-105	61378-101	Switch, Part Of L-105	COM RCVR RF Output
S-106		Not Used	
S-107	61378-101	Part of L-107	COM RCVR RF Input
S-108	61406-1	Part of L-108	
S-109	61406-1	Part of L-109	
S-110	61406-1	Part of L-110	
S-201	61378-101	Part of L-201	
S-202	61395-1	Switch, XTAL, HFO	COM (Front)
S-203	61396-1	Switch, XTAL, HFO	COM (Rear)
S-204	61391-101	Switch, Part of S-104	
S-205	61378-101	Switch, Part of L-205	
S-206		Not Used	
S-207		Not Used	
S-208		Not Used	
S-209	61378-101	Switch, Part of L-209	
S-210		Not Used	
S-211		Not Used	
S-212	61378-101	Switch, Part of L-212	
S-213		Not Used	
S-214		Not Used	
S-215		Not Used	
S-216	61393-101	Switch, Part of L-216	
S-217		Not Used	
S-218		Not Used	
S-219	61393-101	Switch, Part of L-219	
S-220		Not Used	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		S, SWITCHES (CONTINUED)	
S-301	61389-1	Switch, XTAL, HFO NAV.	
S-302	61386-1	Switch, Part of L-302	
S-303	61389-1	Same as S-301	
S-304	61386-1	Switch, Part of L-304	
S-305	61388-1	Switch, G/S	
S-306	61386-1	Switch, Part of L-306	
S-307	61407-1	Switch, Part of L-307	
S-308	61407-1	Switch, Part of L-308	
S-309	61385-1	Switch, G/S	
S-310	61386-1	Switch, Part of L-310	
S-311	61387-1	Switch, G/S	
S-312	61387-1	Same as S-311	
S-313	61387-1	Same as S-311	
S-314		Not Used	
S-315	61384-1	Switch, Part of L-315	
		T, TRANSFORMERS	
T-101	11816-102	Transformer, Com RCVR	HF IF Input
T-102	11817-102	Transformer, Com, RCVR	HF IF Input
T-103	11819-102	Transformer, Com. RCVR	LF IF Input & Interstage
T-104	11819-102	Same as T-103	LF IF Output
T-105	11820-102	Transformer, Com	
T-301	11818-102	Transformer, NAV.	HF IF
T-302	11815-102	Transformer, NAV.	LF IF Input
T-303	11822-102	Transformer, NAV.	LF IF Output
T-401	11821-102	Transformer, Audio Driver	12V. and 24V. Units
T-402	11821-101	Transformer, Audio Output	12V. Unit
T-402	11633-101	Transformer, Audio Output	24V. Unit
T-501	11626-1	Transformer, Power 13.2V	12V. Unit
T-501	11629-1	Transformer, Power 27.5V	24V. Unit
		V, ELECTRON TUBES	
V-101	6BH6	Tube, Electron, Pentode	COM. RCVR RF
V-102	6AK5	Tube, Electron, Pentode	COM. First Mixer
V-103	6EA8	Tube, Electron, Triode Pentode	COM. Second Mixer and COM. Trans LFO
V-104	6BJ6	Tube, Electron, Pentode	COM. First LF IF
V-105	6BJ6	Same as V-104	COM. Second LF IF
V-106	6CW4	Tube, Electron, Triode (Nuvistor)	COM. RCVR LFO
V-201	7551	Tube, Electron, Pentode	Trans. P.A.
V-202	7551	Same as V-201	Trans, Buffer
V-203	8106	Tube, Electron, Tetrode	Trans, RF Amp.
V-204	6AR8	Tube, Electron, Sheet Beam	Trans, Mixer
V-205	7587	Tube, Electron, Tetrode (Nuvistor)	COM. Transceiver HFO/Doubler
V-301	6BH6	Same as V-101	NAV RF Amp.
V-302	6CB6	Tube, Electron, Pentode	NAV First Mixer
V-303	6CB6	Same as V-302	NAV Second Mixer
V-304	6BJ6	Same as V-104	NAV LF, IF
V-305	7898	Tube, Electron, Dual Triode	NAV HFO/Audio Cath. Follower
V-306	6CW4	Same as V-106	NAV LFO
		XT, CRYSTALS, QUARTZ, SUBMINIATURE	
XT-101	72007-121	63.2375 Mc, for 117 Whole Mc	COM. Transceiver
XT-102	72007-122	63.7375 Mc, for 118 Whole Mc	COM. Transceiver
XT-103	72007-123	64.2375 Mc. for 119 Whole Mc	COM. Transceiver
XT-104	72007-124	64.7375 Mc. for 120 Whole Mc	COM. Transceiver
XT-105	72007-125	65.2375 Mc. for 121 Whole Mc	COM. Transceiver

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		XT, CRYSTALS, QUARTZ, SUBMINIATURE (CON'T)	
XT-106	72007-126	65.7375 Mc, for 122 Whole Mc	COM. Transceiver
XT-107	72007-127	66.2375 Mc. for 123 Whole Mc	COM. Transceiver
XT-108	72007-128	66.7375 Mc. for 124 Whole Mc	COM. Transceiver
XT-109	72007-129	67.2375 Mc. for 125 Whole Mc	COM. Transceiver
XT-110	72007-130	67.7375 Mc, for 126 Whole Mc	COM. Transceiver
XT-111	72007-131	68.2375 Mc, for 127 Whole Mc	COM. Transceiver
XT-112	72007-132	68.7375 Mc, for 128 Whole Mc	COM. Transceiver
XT-113	72007-133	69.2375 Mc, for 129 Whole Mc	COM. Transceiver
XT-114	72007-134	69.7375 Mc, for 130 Whole Mc	COM. Transceiver
XT-115	72007-135	70.2375 Mc, for 131 Whole Mc	COM. Transceiver
XT-116	72007-136	70.7375 Mc, for 132 Whole Mc	COM. Transceiver
XT-117	72007-137	71.2375 Mc, for 133 Whole Mc	COM. Transceiver
XT-118	72007-138	71.7375 Mc, for 134 Whole Mc	COM. Transceiver
XT-119	72007-139	72.2375 Mc, for 135 Whole Mc	COM. Transceiver
XT-120	72007-140	9.475 Mc, for .00 Fractional Mc	COM. Transceiver
XT-121	72007-141	9.425 Mc, for .05 Fractional Mc	COM. Transceiver
XT-122	72007-142	9.375 Mc, for .10 Fractional Mc	COM. Transceiver
XT-123	72007-143	9.325 Mc, for .15 Fractional Mc	COM. Transceiver
XT-124	72007-144	9.275 Mc, for .20 Fractional Mc	COM. Transceiver
XT-125	72007-145	9.225 Mc, for .25 Fractional Mc	COM. Transceiver
XT-126	72007-146	9.175 Mc, for .30 Fractional Mc	COM. Transceiver
XT-127	72007-147	9.125 Mc, for .35 Fractional Mc	COM. Transceiver
XT-128	72007-148	9.075 Mc, for .40 Fractional Mc	COM. Transceiver
XT-129	72007-149	9.025 Mc, for .45 Fractional Mc	COM. Transceiver
XT-130	72007-150	8.975 Mc, for .50 Fractional Mc	COM. Transceiver
XT-131	72007-151	8.925 Mc, for .55 Fractional Mc	COM. Transceiver
XT-132	72007-152	8.875 Mc, for .60 Fractional Mc	COM. Transceiver
XT-133	72007-153	8.825 Mc, for .65 Fractional Mc	COM. Transceiver
XT-134	72007-154	8.775 Mc, for .70 Fractional Mc	COM. Transceiver
XT-135	72007-155	8.725 Mc, for .75 Fractional Mc	COM. Transceiver
XT-136	72007-156	8.675 Mc, for .80 Fractional Mc	COM. Transceiver
XT-137	72007-157	8.625 Mc, for .85 Fractional Mc	COM. Transceiver
XT-138	72007-158	8.575 Mc, for .90 Fractional Mc	COM. Transceiver
XT-139	72007-159	8.525 Mc, for .95 Fractional Mc	COM. Transceiver
XT-140	72007-160	96.550 Mc, for 108 Whole Mc	NAV Receiver
XT-141	72007-161	97.550 Mc, for 109 Whole Mc	NAV Receiver
XT-142	72007-162	98.550 Mc, for 110 Whole Mc	NAV Receiver
XT-143	72007-163	99.550 Mc, for 111 Whole Mc	NAV Receiver
XT-144	72007-164	100.550 Mc, for 112 Whole Mc	NAV Receiver
XT-145	72007-165	101.550 Mc, for 113 Whole Mc	NAV Receiver
XT-146	72007-166	102.550 Mc, for 114 Whole Mc	NAV Receiver
XT-147	72007-167	103.550 Mc, for 115 Whole Mc	NAV Receiver
XT-148	72007-168	104.550 Mc, for 116 Whole Mc	NAV Receiver
XT-149	72007-169	105.550 Mc, for 117 Whole Mc	NAV Receiver
	EL-2051	KiT, Crystals, 90 to 360 Ch. Conversion	For COM Transceiver
		MISCELLANEOUS (No Symbol)	
None	41147-3	Socket, Pilot Light, One Insulated Terminal	For I-101, Panel Lamp
None	41225-2	Socket, Pilot Light, Two Insulated Terminals	For I-102, Panel Lamp
None	42015-5	Base, Tube Shield	V-203
	42033-5	Tube Socket, 7 Pin	All 7 pin min. tubes
None	42034-3	Tube Socket, 9 Pin	V-103
None	42034-6	Tube Socket, 9 Pin	V-305
None	42051-1	Tube Shield, Telescoping	V-103,204,305
None	42051-2	Tube Shield, Telescoping, Black	V-202
None	42060-4	Tube Socket, 9 Pin, Recessed	V-201,202,203,204

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		MISCELLANEOUS (No Symbol) (CON'T)	
None	42061-1	Socket, Nuvistor	All Nuvistor Tubes
None	42064-1	Socket, Transistor	MOD-PWR Unit, All Transistors
None	52085-101	Mounting Base	For T12MP12 or T24MP12
None	54451-1	Crystal Holder	COM Mc
None	54514-1	Spring, Grounding	Panel Unit
None	54855-1	Spring, Plate, Cap	Nuvistor
None	55020-2	Insulator, Transistor	For Q-401
None	55520-1	Crystal Holder	NAV. Mc
None	55766-1	Bushing, Knob	NAV. Mc.
None	56404-2	Mask	Panel Unit
None	56409-1	Cover, Top Osc.	NAV. Receiver
None	56410-1	Cover, Bottom Osc.	NAV. Receiver
None	56414-101	Case Assembly	Panel Unit
None	56425-1	Cover, Top Osc.	COM.
None	56426-1	Cover, Bottom Osc.	COM.
None	56438-1	Cover, Dust	MOD-PWR Unit, Two required
None	56443-101	Panel Trim	Panel Unit
None	56446-1	Cover, Amp	COM. R.F. Output
None	61377-1	Detent, Adjustable	NAV. Kc
None	61401-1	Detent, Roller	COM. Kc
None	61402-1	Detent, Spring	COM. Kc
None	61404-101	Assembly, Detent Roller	COM- Kc
None	66507-1	Fuse Holder	MOD-PWR Unit
None	81312-1	Washer, Curved Spring	Case Fastener
None	81330-3	Washer, Shoulder	For Mod-Pwr Unit, Q-401
None	81621-2	Bushing, Knob	NAV. Kc
None	81622-3	Clip, Tube Pin Type	For Mod-Pwr Unit, Q-401,Q-402,
None	81677-11	Nut, Special, Hex	Ground Contact Support
None	84067-3	Stud, Southco (Wing)	Case Fastener
None	84069-1	Receptacle, Southco	Case Fastener
None	84071-1	Hairpin Retainer	Case Fastener
None	84071-2	Cotter, Hair Pin	Panel Unit, Nav. Mc Assy.
None	88111-102	Assembly, Dial	COM. Kc
None	88111-105	Assembly Dial	NAV. Kc
None	88129-2	Knob	Volume Control
None	88132-101	Assembly, Knob	COM. Mc
None	88145-101	Assembly, Knob	NAV. Mc
None	88146-3	Knob	COM. Kc
None	88146-4	Knob	NAV. Kc
None	88148-2	Knob	Squelch Control
None	90617-2	Cable only, two branches, no Connectors	For CN-89 Chassis
None	90618-96	Cable, Mod-Pwr and Accessory, 8' Long	Interconnections
None	90618-190	Cable, Mod-Pwr and Accessory, 16' Long	Interconnections
None	EL-2053	Cable, Glide Slope Switching	Interconnections

COMMENTS **SCHEMATICS**



7.-MEASURED TO TERMINAL 15 OF P-101.
8.-MEASURED TO TERMINAL 8 OF P-101.
9.-MEASURED TO TERMINAL 7 OF P-101.
TERMINALS 4,5,6, AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS. VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.

10.-VOLTAGES SHOWN ARE AVERAGE. VARIATIONS OF ± 20 % CAN BE EXPECTED.
11.-MEASURED THRU A 1 MEG. OHM RESISTOR.
12.-MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10 MC) VOLTMETER.
13.-VOLTAGE SHOWN ABOVE LINE - EXAMPLE VOLTAGE / RESISTANCE

Figure 11b.

SCHEMATIC, *narco* Mark-12. PANEL UNIT
For CN89-C & D and CNP89-C & D

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		MISCELLANEOUS (No Symbol) (CON'T)	
None	42061-1	Socket, Nuvistor	All Nuvistor Tubes
None	42064-1	Socket, Transistor	MOD-PWR Unit, All Transistors
None	52085-101	Mounting Base	For T12MP12 or T24MP12
None	54451-1	Crystal Holder	COM Mc
None	54514-1	Spring, Grounding	Panel Unit
None	54855-1	Spring, Plate, Cap	Nuvistor
None	55020-2	Insulator, Transistor	For Q-401
None	55520-1	Crystal Holder	NAV. Mc
None	55766-1	Bushing, Knob	NAV. Mc.
None	56404-2	Mask	Panel Unit
None	56409-1	Cover, Top Osc.	NAV. Receiver
None	56410-1	Cover, Bottom Osc.	NAV. Receiver
None	56414-101	Case Assembly	Panel Unit
None	56425-1	Cover, Top Osc.	COM.
None	56426-1	Cover, Bottom Osc.	COM.
None	56438-1	Cover, Dust	MOD-PWR Unit, Two required
None	56443-101	Panel Trim	Panel Unit
None	56446-1	Cover, Amp	COM. R.F. Output
None	61377-1	Detent, Adjustable	NAV. Kc
None	61401-1	Detent, Roller	COM. Kc
None	61402-1	Detent, Spring	COM. Kc
None	61404-101	Assembly, Detent Roller	COM- Kc
None	66507-1	Fuse Holder	MOD-PWR Unit
None	81312-1	Washer, Curved Spring	Case Fastener
None	81330-3	Washer, Shoulder	For Mod-Pwr Unit, Q-401
None	81621-2	Bushing, Knob	NAV. Kc
None	81622-3	Clip, Tube Pin Type	For Mod-Pwr Unit, Q-401,Q-402
None	81677-11	Nut, Special, Hex	Ground Contact Support
None	84067-3	Stud, Southco (Wing)	Case Fastener
None	84069-1	Receptacle, Southco	Case Fastener
None	84071-1	Hairpin Retainer	Case Fastener
None	84071-2	Cotter, Hair Pin	Panel Unit, Nav. Mc Assy.
None	88111-102	Assembly, Dial	COM. Kc
None	88111-105	Assembly Dial	NAV. Kc
None	88129-2	Knob	Volume Control
None	88132-101	Assembly, Knob	COM. Mc
None	88145-101	Assembly, Knob	NAV. Mc
None	88146-3	Knob	COM. Kc
None	88146-4	Knob	NAV. Kc
None	88148-2	Knob	Squelch Control
None	90617-2	Cable only, two branches, no Connectors	For CN-89 Chassis
None	90618-96	Cable, Mod-Pwr and Accessory, 8' Long	Interconnections
None	90618-190	Cable, Mod-Pwr and Accessory, 16' Long	Interconnections
None	EL-2053	Cable, Glide Slope Switching	Interconnections

COMMENTS.

The revised schematics in this Supplement No. 2, represent differences of a minor nature, based on developments during successive production runs and on field experience.

NOTE:

Because of a lack of space the functions of S-311 and S-312, near the lower right of Fig. 11b. on this sheet, are not fully stated.

S-311 "EVEN MC" means: "EVEN whole Mc Channels (108 Mc. or 110 Mc.) associated with the ODD Kc. (Fractional Mc.) Channels .1, .3, .5, .7, .9 Mc."

S-312 "ODD MC" means: "ODD whole Mc. Channels (109 Mc. or 111 Mc.) associated with the ODD Kc. (Fractional Mc.) Channels .1, .3, .5, .7, .9 Mc."

COMMENTS SCHEMATICS

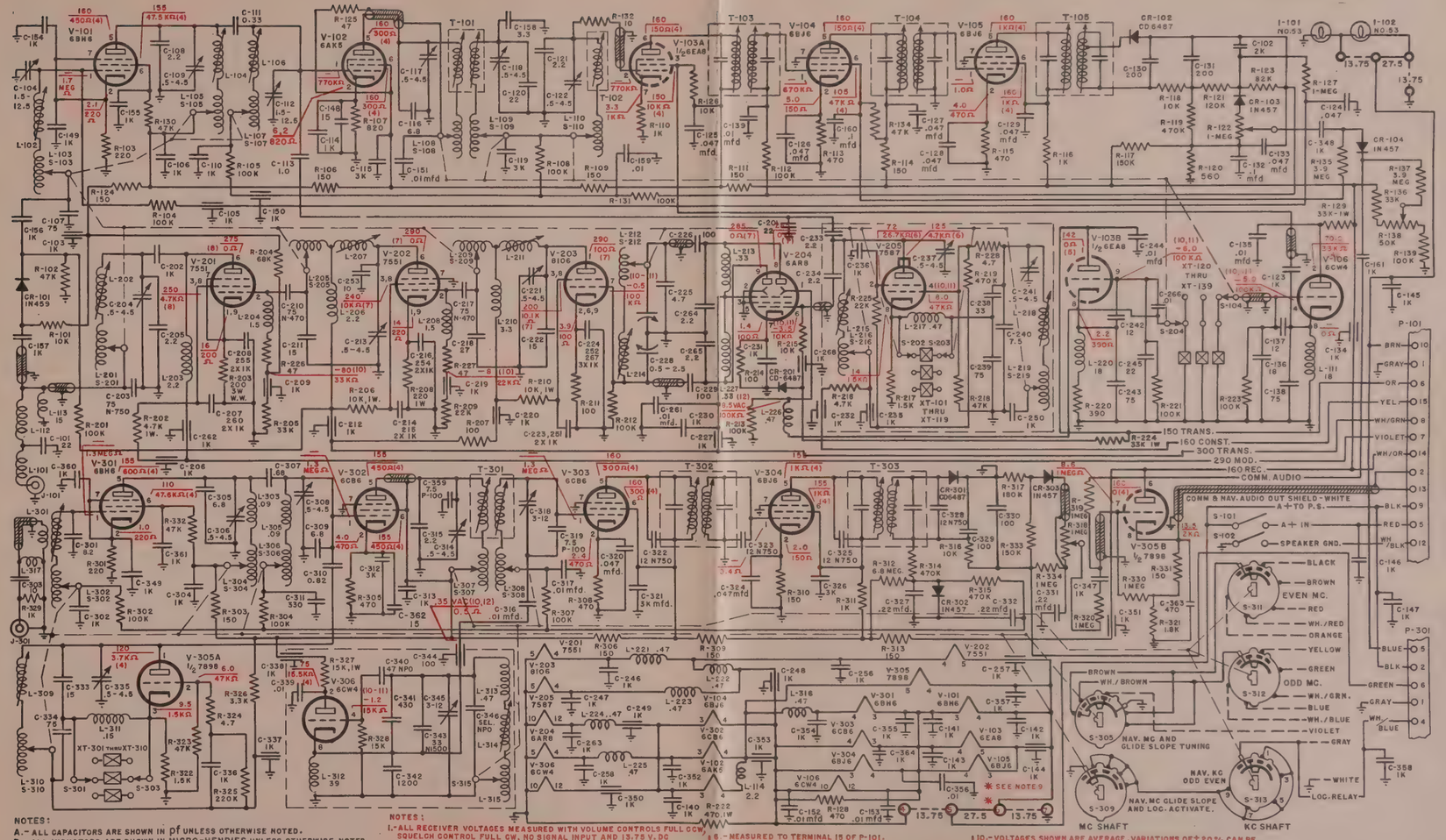

NOTES:
A.-ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
B.-ALL INDUCTORS ARE SHOWN IN MICRO-HENRIES UNLESS OTHERWISE NOTED.
C.-ALL RESISTORS ARE SHOWN IN ONE-HALF WATT UNLESS OTHERWISE NOTED.
D.-"K" DENOTES ONE THOUSAND. "M" DENOTES ONE MILLION.
NOTES:
1.-ALL RECEIVER VOLTAGES MEASURED WITH VOLUME CONTROLS FULL CCW, SQUELCH CONTROL FULL CW, NO SIGNAL INPUT AND 13.75 V. DC APPLIED TO UNIT.
2.-ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V DC APPLIED TO UNIT.
3.-ALL RESISTANCES MEASURED TO CHASSIS (GND.) UNLESS OTHERWISE NOTED.
4.-MEASURED TO TERMINAL 14 OF P-101.
5.-MEASURED TO TERMINAL 6 OF P-101.
6.-MEASURED TO TERMINAL 15 OF P-101.
7.-MEASURED TO TERMINAL 8 OF P-101.
8.-MEASURED TO TERMINAL 7 OF P-101.
9.-TERMINALS 4, 5, 6, AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS, VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.
10.-VOLTAGES SHOWN ARE AVERAGE. VARIATIONS OF ±20% CAN BE EXPECTED.
11.-MEASURED THRU A 1 MEG-OHM RESISTOR.
12.-MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10 MC) VOLTMETER.
13.-VOLTAGE SHOWN ABOVE LINE-EXAMPLE VOLTAGE / RESISTANCE
CONN. & NAV. AUDIO OUT SHIELD - WHITE
A+ TO P.S.
A+ IN
SPEAKER GND.
BLACK
BROWN
EVEN MC.
RED
WH./RED
ORANGE
YELLOW
GREEN
ODD MC.
WH./GRN.
BLUE
WH./BLUE
VIOLET
GRAY
WHITE
LOC. RELAY
NAV. MC AND GLIDE SLOPE TUNING
NAV. MC GLIDE SLOPE AND LOC. ACTIVATE.
NAV. KC ODD EVEN
MC SHAFT
KC SHAFT
150 TRANS.
160 CONST.
300 TRANS.
290 MOD.
160 REC.
COMM. AUDIO
SEE NOTE 9

Figure 11b.
SCHEMATIC, *narco* Mark-12. PANEL UNIT
For CN89-C & D and CNP89-C & D

T-02177A-Rev. BB 5-13-64 ECN-4317

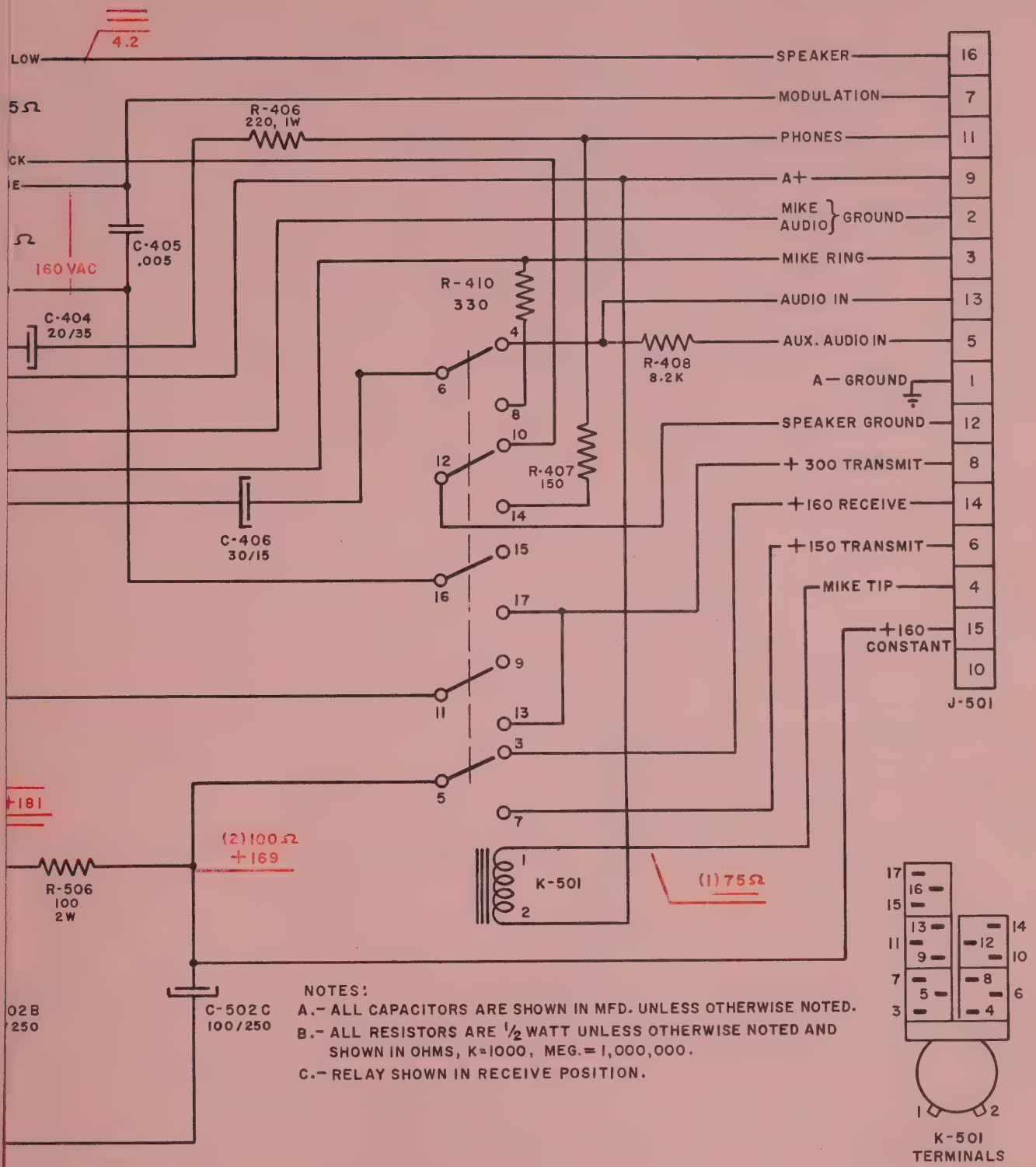
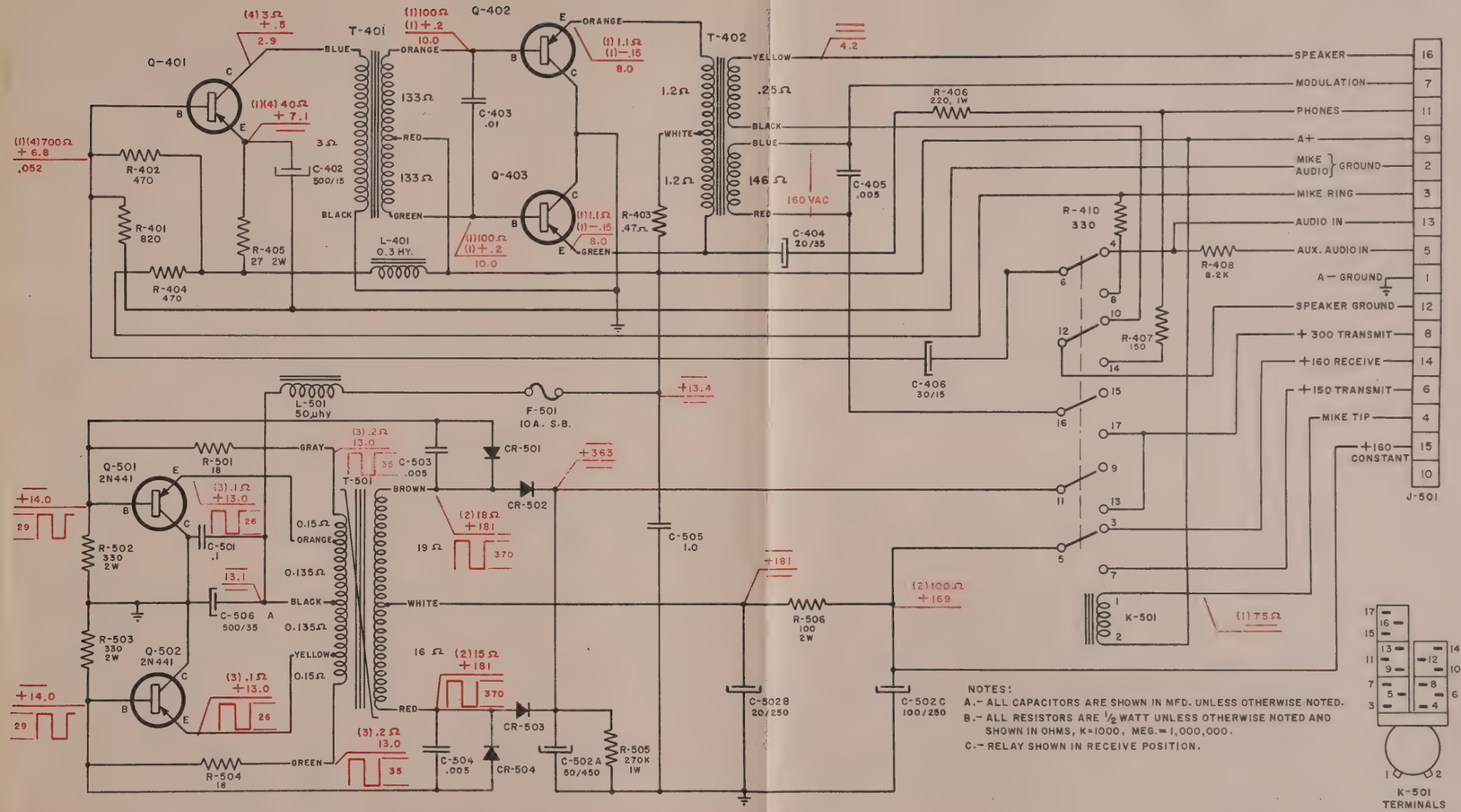


Figure 12a.
SCHEMATIC, MODULATOR POWER UNIT, T-12MP-12,
for *narco* Mark-12 operation on 12 Volts.
CNPA89-B



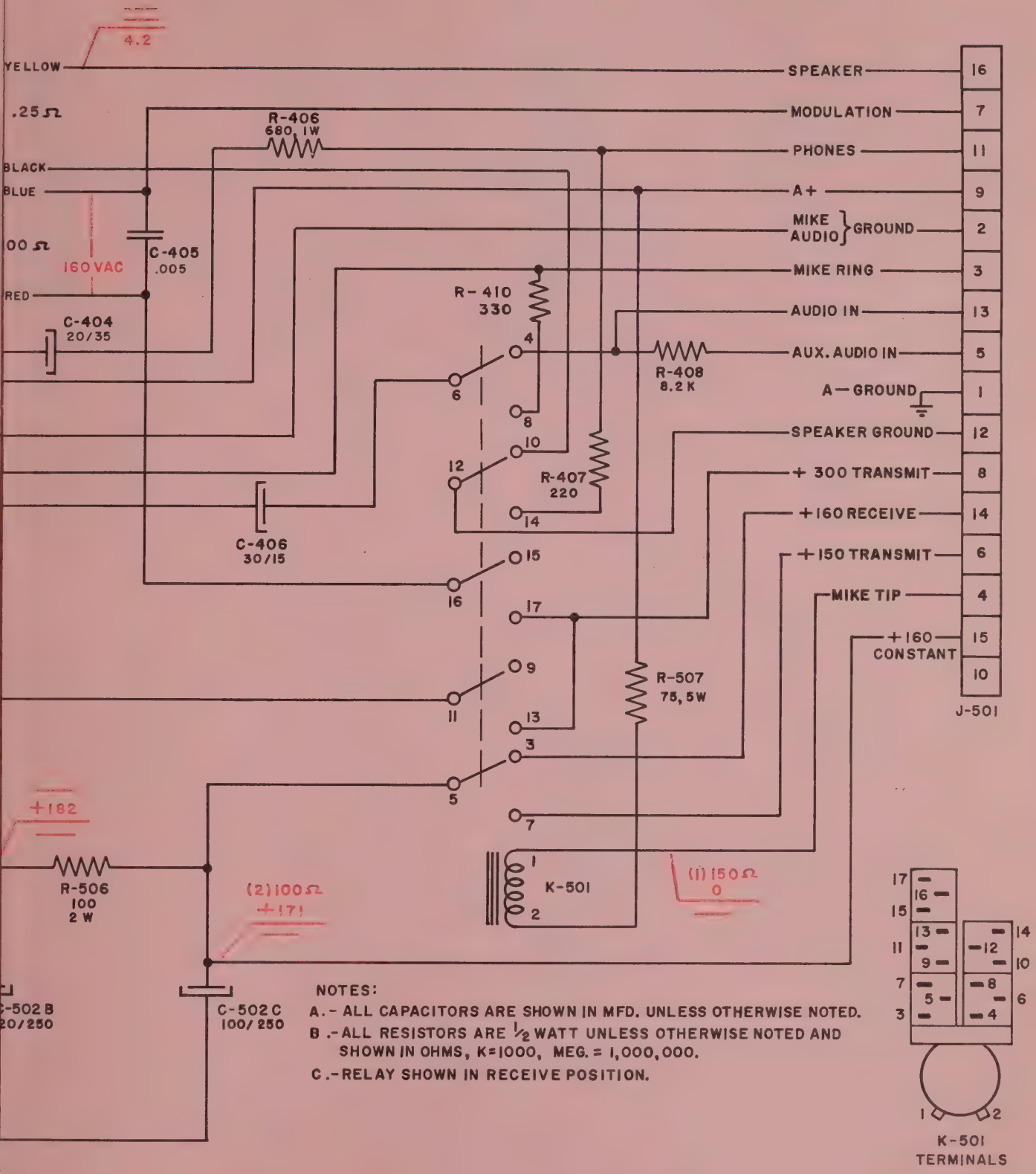
NOTES:
(1) - MEASURED WITH RESPECT TO A +, PIN-9.
(2) - MEASURED WITH RESPECT TO WHITE LEAD OF T-501.
(3) - MEASURED WITH RESPECT TO BLACK LEAD OF T-501.
(4) - MEASURED WITH Q-401 REMOVED.

RESISTANCE READING TAKEN WITH CONNECTOR DISCONNECTED.
OTHER READINGS ARE TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS OF AUDIO OUT, WITH NORMAL 13.75 V. INTO POWER CABLE AT MARK-12. (AUDIO FREQUENCY 1000 CYCLES)
ALL DC MEASUREMENTS ARE WITH RCA VOLTOHMIST VTVM OR EQUIVALENT.
ALL WAVEFORMS ARE MEASURED WITH A DUMONT 401B OSCILLOSCOPE OR EQUIVALENT.
ALL AC MEASUREMENTS WITH BALLANTINE AC VOLTMETER OR EQUIVALENT.

TEST DATA LINE
RESISTANCE
DC VOLTAGE AND POLARITY
AC VOLTAGE OR WAVE SHAPE & P-P VOLTAGE

Ref. T-02178-J 2-14-64 ECN-4250

Figure 12a.
SCHEMATIC, MODULATOR POWER UNIT, T-12MP-12, for *narco* Mark-12 operation on 12 Volts.
CNPA89-B



NOTES:

A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.

B .- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG. = 1,000,000.

C .- RELAY SHOWN IN RECEIVE POSITION.

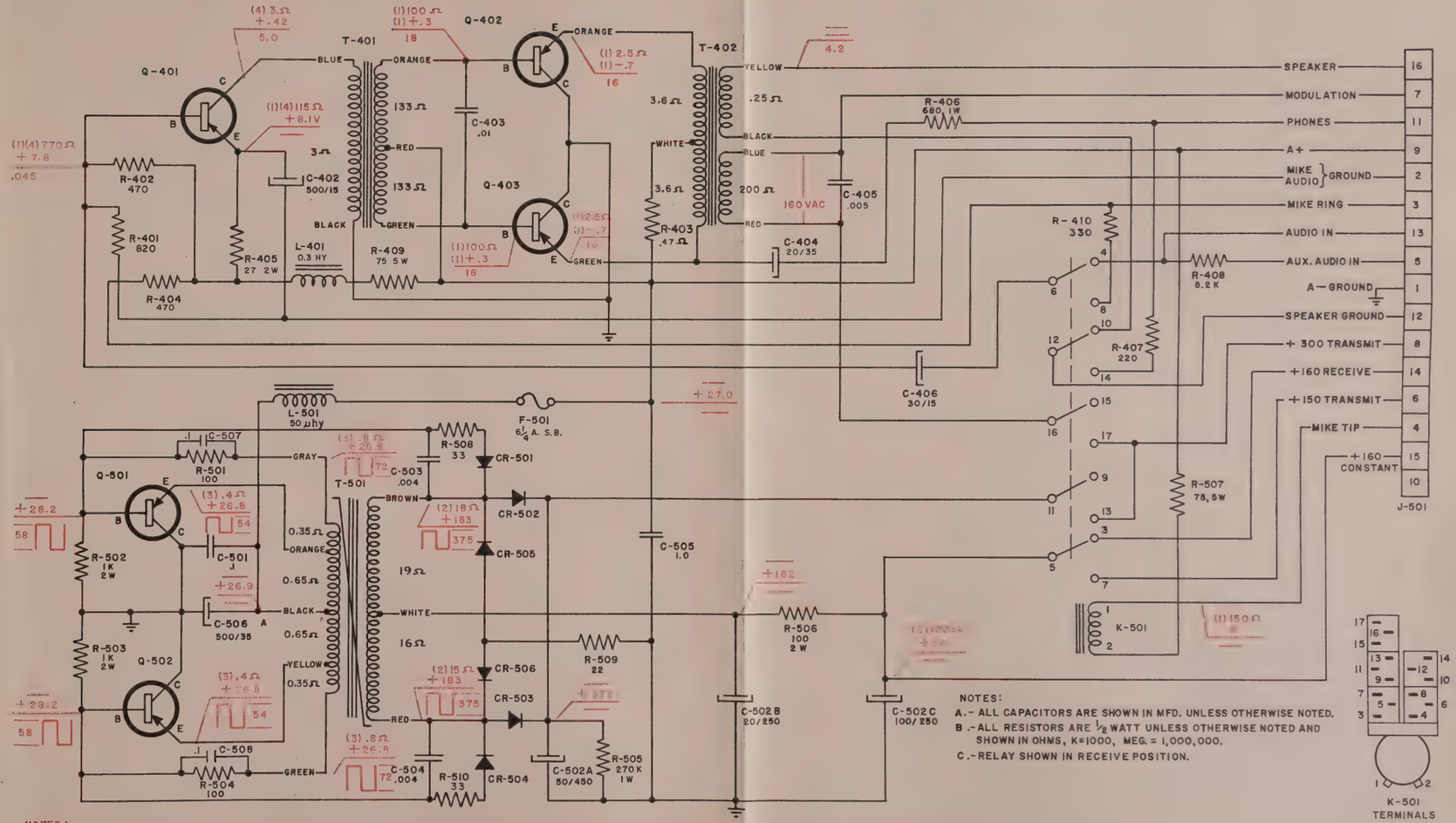
TEST DATA LINE

RESISTANCE

DC VOLTAGE AND POLARITY

AC VOLTAGE OR
WAVE SHAPE & P-P VOLTAGE

Figure 13a.
SCHEMATIC, MODULATOR POWER UNIT T-24MP-12
for *narco* Mark-12 operation on 24 Volts.
CNPB89-B



NOTES:
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG. = 1,000,000.
C.- RELAY SHOWN IN RECEIVE POSITION.

NOTES:-
(1) - MEASURED WITH RESPECT TO A+, PIN-9.
(2) - MEASURED WITH RESPECT TO WHITE LEAD OF T-501.
(3) - MEASURED WITH RESPECT TO BLACK LEAD OF T-501.
(4) - MEASURED WITH Q-401 REMOVED.

RESISTANCE READINGS TAKEN WITH CONNECTOR DISCONNECT
OTHER READINGS ARE TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS OF AUDIO OUT (FREQUENCY 1000 CYCLES), WITH NORMAL 27.5V. INTO POWER CABLE AT MARK-12.
ALL DC MEASUREMENTS ARE WITH RCA VOLTOHMIST VTVM OR EQUIVALENT.
ALL WAVEFORMS ARE MEASURED WITH A DUMONT 401B OSCILLOSCOPE OR EQUIVALENT.
ALL AC MEASUREMENTS WITH BALLANTINE AC VOLTMETER OR EQUIVALENT.

TEST DATA LINE
RESISTANCE
DC VOLTAGE AND POLARITY
AC VOLTAGE OR WAVE SHAPE & P-P VOLTAGE

Figure 13a.
SCHEMATIC, MODULATOR POWER UNIT T-24MP-12
for *narco* Mark-12 operation on 24 Volts.
CNPB89-B

Ref. T-02183-D 4-10-64 ECN-4304

Supplement No. 3

For CN89-E & F and CNP89-E & F

also CNPA89-C & D and CNPB89-C & D

MARK-12
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL

SUPPLEMENT No. 3

FOR PANEL UNITS:

CN89-E & F.
CNP89-E & F.

FOR MODULATOR-POWER UNITS:

CNPA89-C & D.
CNPB89-C & D.

NOTE

This supplement is concerned primarily with two changes:

1. The NAV Receiver L.F.-I.F. has been changed from 1.425 Mc to 1.125 Mc.
2. An emitter follower COM/NAV Audio Output Amplifier (Q-301) has been added.

Other minor changes in both the Panel and Modulator-Power Units have been made to improve the operation of current production equipments.

CONTENTS

4-D. NAV Receiver Description, page 93.

5-F. NAV Receiver Alignment, page 95.

6-C. BLOCK DIAGRAM, page 97.

7-B. LIST of PARTS, page 99.

8-B. SCHEMATICS, page 111.

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

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4-D. NAVIGATION RECEIVER CN89-E and LATER.

A double conversion superheterodyne circuit is employed in the navigation receiver of the Mark-12. The desired signal enters the receiver at the navigation receiver antenna connector, J-301. The signal is applied to the first of three tuned RF circuits. These circuits are tuned in steps of one megacycle by the use of gang tuned variable inductors. The RF signal is amplified by V-301 (6BH6) and applied through a capacitively coupled, double tuned circuit to the control grid of the first mixer, V-302.

The high frequency oscillator (HFO), V-305, is a crystal stabilized grounded grid oscillator. Its frequency range, using fifth overtone crystals, is 96.55 Mc to 105.55 Mc in one megacycle steps. Fundamental oscillator energy is injected through C-310 to the control grid of the first mixer, V-302.

The high frequency IF (first IF) is produced by selecting the difference frequency betwen the incoming RF signal and the HFO injection energy. This difference frequency selection is accomplished by a tuned circuit containing T-301. The tuning of T-301 is done in 100 kilocycle steps by gang switched step inductors. The HF IF is tuned over the range of 11.45 Mc to 12.35 Mc. The output of the HF IF is applied to the control grid of the second mixer, V-303.

The low frequency oscillator (LFO) is a Colpitts oscillator operating in the range from 10.325 Mc to 11.225 Mc. It is inductively tuned, by the step inductor L-315, in 100 kilocycle steps. The output of this oscillator is injected to the control grid of the second mixer, V-303, through C-316 and the secondary circuit of T-301.

The low frequency IF (second IF) is produced by selecting the difference frequency between the output of the HF IF and the LFO injection energy. This selection is done by T-302, which is the first of two 1.125 Mc IF transformers. T-302 and T-303 are overcoupled to give an adequate bandwidth. The signal from T-302 is applied to the control grid of V-304. It is amplified by V-304 and passed through T-303 to CR-301, which is a silicon diode detector.

The omni output is applied from the diode load directly to the omni converter input. The peak limiting noise limiter, CR-303, is a silicon diode. The output of the noise limiter is the input to the audio volume control, R-318. The output of the audio volume control is applied through R-320 and C-347 to the control grid of the cathode follower V-305B. The plate output of V-305B in turn goes to the base input of the emitter follower Q-301. The output of Q-301 then goes to the high level audio circuits in the Modulator-Power Unit.

The delayed AVC is developed by detector current flow through R-317, R-333, and R-316 and is applied to the RF and IF stages with the exception of the last IF stage, V-304. The time constant of the AVC is very slow to provide accurate omni range bearings.

REFERENCE—Page 15 in original manual.

5-F. NAVIGATION RECEIVER ALIGNMENT.

Reference: Schematic Fig. 11c, page 111

5-F,1. Low Frequency IF Amplifier.

Procedure:

a. Connect AC VTVM to the junction of R-316, R-333, and C-330.

b. Remove all connections from Pin 1, V-303. Connect a 47 ohm resistor from Pin 1, V-303 to ground, and connect the signal generator to Pin 1, V-303. Set the signal generator to 1.125 Mc, 400 cps 30% modulation. Increase the signal generator output for a usable indication on the AC VTVM.

c. Set the signal generator to 1.115 Mc and tune the primary and secondary tuning slugs of T-302 and T-303 for maximum indication on the AC VTVM.

d. Set the signal generator to 1.135 Mc and tune the primary and secondary tuning slugs of T-302 and T-303 for maximum indication on the AC VTVM.

e. Repeat steps c. and d. until no further increase in AC VTVM indication is obtained and peak amplitudes are approximately equal with approximately 20 Kc peak separation. The hole depth between the two peaks should be approximately 1.0 db.

f. Figure 3a, page 96, illustrates the low frequency IF response.

g. Remove the signal generator and the 47 ohm resistor from Pin 1, V-303, and reconnect the components previously removed. Remove the AC VTVM from the junction of R-316, R-333, and C-330.

Normal Indication:

350 μv maximum input for 1.9 VAC detector output.

5-F,2. Selectivity—Low Frequency IF Bandwidth

Procedure:

a. Connect AC VTVM to the junction of R-316, R-333, and C-330.

b. Remove all connections from Pin 1, V-303. Connect a 47 ohm resistor from Pin 1, V-303 to ground, and connect the Signal Generator to Pin 1, V-303. Set the signal generator to 1.125 Mc 400 cps 30% modulation. Adjust the signal generator output to produce a usable indication on the AC VTVM.

c. Vary the signal generator frequency across the LF IF response. It will be noted that the IF response peaks approximately 10 Kc either side of 1.125 Mc, with 1.125 Mc falling at the bottom of a "hole" or "dip" in the response between the two peaks. See Figure 3a, page 96, for the low frequency IF response. Use the AC VTVM indication at this "hole" in the response, at 1.125 Mc, as the reference level to measure bandwidth.

d. With the reference level set, increase the signal generator output 6 db (2:1). Tune the signal generator frequency below 1.125 Mc until the reference level is obtained on the AC VTVM. Note this frequency. Tune the signal generator frequency above 1.125 Mc until the reference level is obtained on the AC VTVM. Note this frequency. The difference between the two noted frequencies is the total 6 db bandwidth.

e. With the reference level set, increase the signal generator output 60 db (1000:1). Tune the signal generator frequency below 1.125 Mc until the reference level is obtained on the AC VTVM. Note this frequency. Tune the signal generator frequency above 1.125 Mc until the reference level is obtained on the AC VTVM. Note this frequency. The difference between the two noted frequencies is the total 60 db bandwidth.

f. Remove the signal generator and the 47 ohm resistor from Pin 1, V-303, and reconnect the components previously removed. Remove the AC VTVM from the junction of R-316, R-333 and C-330.

Normal Indication:

6 DB— 40 Kc minimum total bandwidth
60 DB—200 Kc maximum total bandwidth

REFERENCE—Page 24 in original manual.

5-F,4. Low Frequency Oscillator.

PRIMARY METHOD

Procedure:

a. Determine that the HF IF is properly aligned.

b. Disconnect Pin 5, V-303 from T-302. Connect a 39 μhy choke from Pin 6, V-303 to Pin 5, V-303. Connect a 47 μμfd 500V capacitor from Pin 5, V-303 to the input of the frequency counter. Remove all connections from Pin 1, V-302.

c. Set L-314 to mid-range. (Tuning screw half way in.) Set C-345 to mid-range. (Slot for tuning tool horizontal with respect to the chassis.)

d. Set the fractional Mc selector to the 0.9 position. Observe the frequency indicated on the counter. Adjust L-314 for an indication of 11.225 Mc on the counter.

e. Set the fractional Mc selector to the 0.0 position. Observe the frequency indicated on the counter. Adjust C-345 for an indication of 10.325 Mc on the counter.

f. Repeat steps d. and e. until the circuit is tracked. Check the frequency of each fractional Mc position. The frequency must be within ±8 Kc of the center frequency for each position. See Table IVa., below.

g. Reconnect the components previously removed from Pin 1, V-302. Remove the counter, 47 uufd capacitor, and 39 μhy choke from Pin 5 and Pin 6 of V-103. Reconnect Pin 5, V-303 to T-302.

TABLE IVa.

OSCILLATOR FREQUENCY — LFO

NAVIGATION RECEIVER

Channel	Center Frequency (Mc)
.0	10.325
.1	10.425
.2	10.525
.3	10.625
.4	10.725
.5	10.825
.6	10.925
.7	11.025
.8	11.125
.9	11.225

ALTERNATE METHOD

Procedure:

a. Calibrate a BC-221 frequency meter to the nearest crystal check point related to the 10 Mc through 11 mc range.

b. Connect a length of insulated wire (#22 hook up wire is adequate) to the antenna post of the BC-221. Insert the other end of the wire into the plate and screen area of V-303. Take care that the wire is well away from the control grid area of V-303 or oscillator frequency pulling will be experienced.

c. Set the fractional Mc selector to the 0.9 position. Set the BC-221 to 11.225 Mc. Adjust L-314 for a zero beat from the BC-221.

d. Set the fractional Mc selector to the 0.0 position. Set the BC-221 to 10.325 Mc. Adjust C-345 for a zero beat from the BC-221.

c. Repeat steps c. and d. until the circuit is tracked. Check the frequency of each fractional Mc position. The frequency must be within ±8 Kc of the center frequency for each position.

Normal Indication:

Each fractional Mc position must be no more than ±8 Kc from its center frequency.

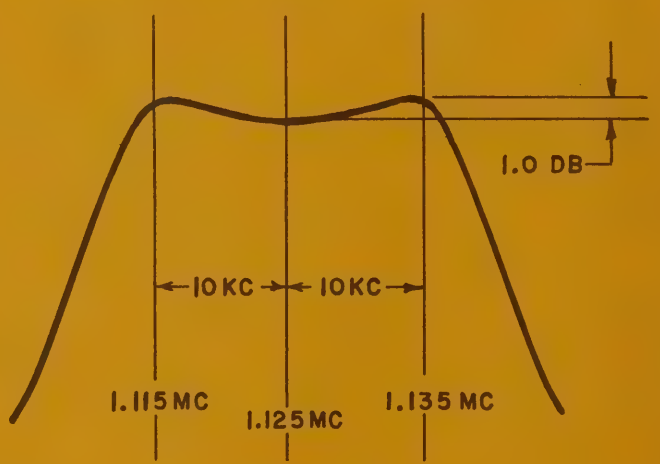
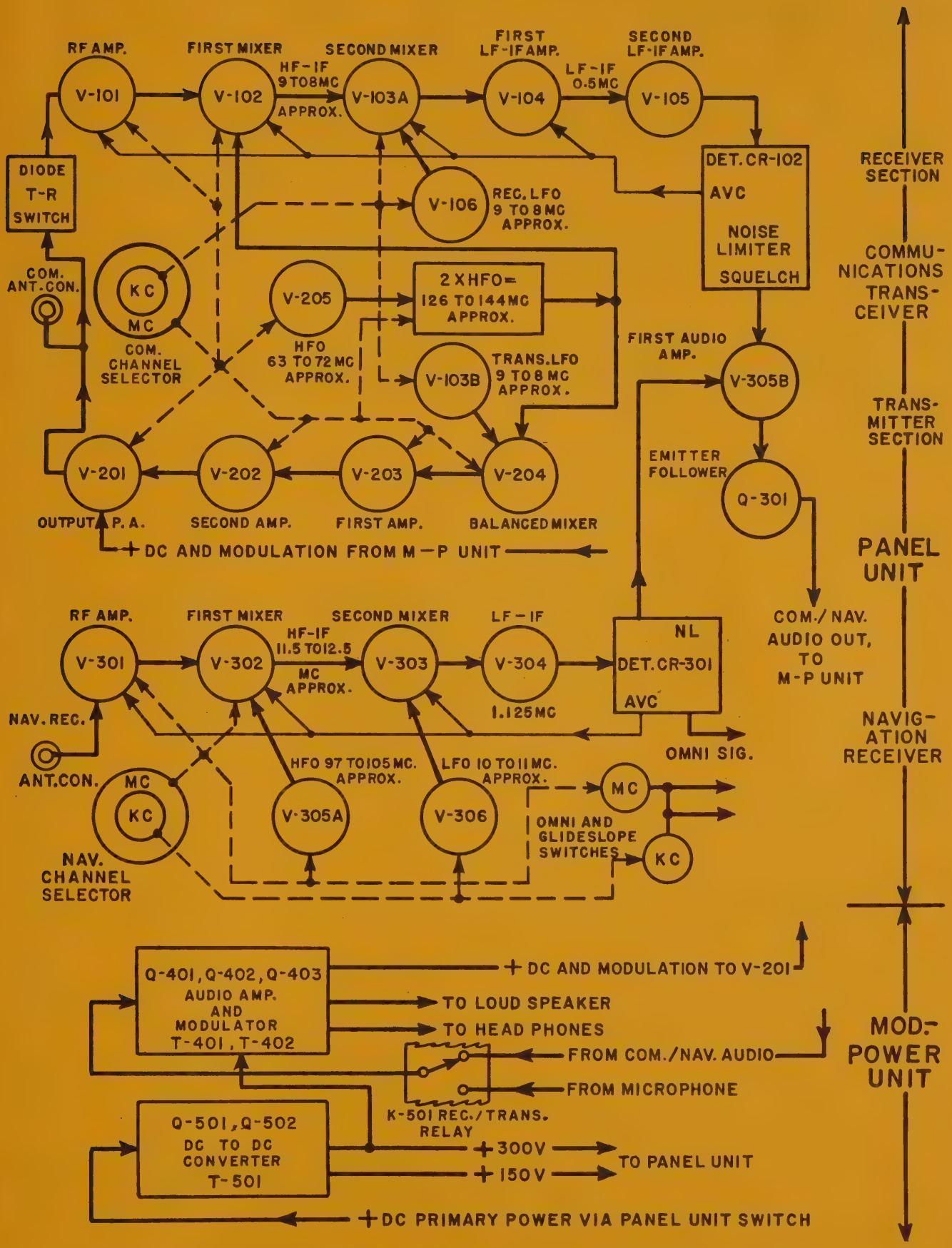


Figure 3a.
narco Mark-12 NAV. Receiver.
L.F. I.F. Response.

REFERENCES—Pages 25 and 30 in original manual.



BLOCK DIAGRAM
narco Mark-12 COMMUNICATIONS TRANSCEIVER

REPLACEMENT PARTS

This Supplement No. 3, Replacement Parts List is a complete integrated list for all Panel Units (CN89-A thru F and CNP89-A thru F) and all Modulator-Power Units (CNPA89-A thru D and CNPB89 A thru D).

A. INTRODUCTION.

This list of Replacement Parts contains the items that may be considered replaceable in the field. They should preferably be ordered by Symbol No., Part No., and Description.

The Replacement Parts are listed by their Symbol letter and number, alphabetically then numerically. Some items without a Symbol No., are listed numerically by Part Number in a "Miscellaneous" List following the listings by Symbol numbers. A few items without a Symbol No. may be listed with associated parts such as connectors.

The "Function or Application" column is intended to separate the description of the item from its purpose in the equipment. It may also be found useful when working with the Illustrations and Schematics.

B. LIST OF PARTS.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-101	21201-220	Ceramic Tubular, 500V, 22 micromicrofarads, ±10%	
C-102	21291-15	Ceramic Disc, 500V, .002 microfarads, ±10%	
C-103	21298-1	Feed-Thru, 500V, .001 microfarad, +100% −0%	
C-104	22019-2	Variable Plunger, 500V, 1.5 − 12.5 micromicrofarads	
C-105	21298-1	Same as C-103	COM RCVR RF Input
C-106	21291-21	Ceramic Disc., 1000V., .001 microfarad, ±20%	
C-107	21384-750	Ceramic Tubular, 500V, 75 micromicrofarads, ±5%	
C-108	24516-229	Ceramic Disc., 500V, 2.2 micromicrofarads, ±0.25	
C-109	22019-1	Variable Plunger, 500V, 0.5 − 4.5 micromicrofarads	COM RCVR RF Output
C-110	21291-21	Same as C-106	
C-111	24509-338	Ceramic, 500V., .33 micromicrofarads, ±5%	
C-112	22019-2	Same as C-104	
C-113	24502-109	Ceramic, 500V., 1.0 micromicrofarads, ±5%	COM RCVR First Mixer Input
C-114	21291-21	Same as C-106	
C-115	21291-4	Ceramic Disc, 500V, .003 microfarad, ±80% − 20%	
C-116	24516-689	Ceramic Disc, 500V., 6.8 micromicrofarads ±0.5 micromicrofarads	
C-117	22019-1	Same as C-109	COM RCVR First Mixer Output
C-118	22019-1	Same as C-109	COM RCVR HF IF
C-119	21291-9	Ceramic Disc, 500V., .003 microfarad, ±10%	
C-120	21201-220	Same as C-101	
C-121	24516-229	Same as C-108	
C-122	22019-1	Same as C-109	COM RCVR Second Mixer Input
C-123	21291-21	Same as C-106	
C-124	23085-71	Mylar, 100V., .047 microfarad, ±10%	
C-125	23085-171	Mylar, 200V., .047 microfarad, ±10%	
C-126	23085-71	Same as C-124	
C-127	23085-171	Same as C-125	
C-128	23085-71	Same as C-124	
C-129	23085-171	Same as C-125	
C-130	21291-11	Ceramic Disc, 500V., 200 micromicrofarads, ±10%	
C-131	21291-11	Same as C-130	
C-132	23085-75	Mylar, 100V, 0.1 microfarad, ±10%	
C-133	23085-71	Same as C-124	
C-134	21298-1	Same as C-103	
C-135	21291-6	Ceramic Disc, 500V., 0.01 microfarad, GMV	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS, (Continued)	
C-136	24049-180	Dipped Mica, 500V., 18 micromicrofarads, ±5%	
C-137	24049-120	Dipped Mica, 500V., 12 micromicrofarads, ±1.0 micromicrofarads	
C-138	24049-750	Dipped Mica, 500 V., 75 micromicrofarads, ±5%	
C-139	23085-113	Mylar, 200V., .01 microfarad, ±20%	
C-140	21291-21	Same as C-106	
C-141	21291-21	Same as C-106	
C-142	21291-21	Same as C-106	
C-143	21291-21	Same as C-106	
C-144	21298-1	Same as C-103	
C-145	21291-21	Same as C-106	
C-146	21291-21	Same as C-106	
C-147	21291-21	Same as C-106	
C-148	24516-150	Ceramic Disc, 15 micromicrofarads, ±10%	
C-149	21291-21	Same as C-106	
C-150	21298-1	Same as C-103	
C-151	21291-6	Same as C-135	
C-152	21291-5	Ceramic Disc, 50 V., .01 mf, +80% −30%	
C-153	21291-5	Same as C-152	
C-154	21291-21	Same as C-106	
C-155	21291-21	Same as C-106	
C-156	21291-21	Same as C-106	
C-157	21291-21	Same as C-106	
C-158	24516-339	Ceramic Disc, 500V., 3.3 micromicrofarads, ±10%	
C-159	23085-113	Same as C-139	
C-160	23085-125	Mylar, 200V, 0.1 μfd, ±20%	CN-89-B,-C,-D. CNP-89-B,-C,-D
C-161	23085-151	Mylar, Tubular, 200V, .001 mfd, ±10%	CN-89-B,-C,-D CNP-89-B,-C,-D
→ C-162	23085-113	Same as C-139	CN-89-E and later. CN-P89-F and later.
C-201	21201-220	Same as C-101	CN-89-C,-D. CNP-89-C,-D
C-202	21291-21	Same as C-106	
C-203	21384-750	Same as C-107	
C-204	22019-1	Same as C-109	XMTR PA Output
C-205	21201-229	Ceramic Tubular, 500 V, 2.2 micromicrofarads, 0.25 micromicrofarads	
C-206	21298-1	Same as C-103	
C-207	21291-21	Same as C-106	
C-208	21291-21	Same as C-106	
C-209	21298-1	Same as C-103	
C-210	21383-750	Ceramic Tub., 500V., 75 micromicrofarads, ±5%	
C-211	21201-150	Ceramic Tub., 500V., 15 mmf, ±10%	
C-212	21298-1	Same as C-103	
C-213	22019-1	Same as C-109	XMTR Buffer Output
C-214	21291-21	Same as C-106	
C-215	21291-21	Same as C-106	
C-216	21291-21	Same as C-106	
C-217	21383-750	Same as C-210	
C-218	21201-270	Ceramic Tub., 500V., 27 mmf, ±10%	
C-219	21298-1	Same as C-103	
C-220	21298-1	Same as C-103	
C-221	22019-1	Same as C-109	XMTR RF AMp. Output
C-222	21201-150	Same as C-211	
C-223	21291-21	Same as C-106	
C-224	21291-21	Same as C-106	
C-225	21201-479	Ceramic Tub., 500 V., 4.7 mmf, ±0.5 micromicrofarads	
C-226	21291-14	Ceramic Disc, 500V., 100 mmf, ±10%	
C-227	21298-1	Same as C-103	
C-228	22029-1	Split Stator Glass, 500V., 0.5 to 2.5 micromicrofarads	XMTR Mixer
C-229	21291-14	Same as C-226	
C-230	21291-21	Same as C-106	
C-231	21291-21	Same as C-106	
C-232	21298-1	Same as C-103	
C-233	24516-229	Same as C-108	
C-234	24516-229	Same as C-108	
C-235	21298-1	Same as C-103	

→ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS, (Continued)	
C-236	21291-21	Same as C-106	
C-237	22019-1	Same as C-109	COM TCVR HFO/Doubler Output
C-238	24049-330	Dipped Mica, 500V., 33 micromicrofarads, ±5%	
C-239	24049-750	Same as C-138	
C-240	21201-759	Ceramic Tub., 500V., 7.5 micro micrófarads, ±0.5 micromicrofarad	
C-241	22019-1	Same as C-109	COM TCVR HFO/Doubler Input
C-242	24049-120	Same as C-137	
C-243	24049-750	Same as C-138	
C-244	21291-6	Same as C-135	
C-245	24049-220	Dipped Mica, 500V., 22 micromicrofarads, ±5%	
C-246	21291-21	Same as C-106	
C-247	21291-21	Same as C-106	
C-248	21298-1	Same as C-103	
C-249	21298-1	Same as C-103	
C-250	21291-19	Ceramic Disc, 500V., 1K micromicrofarad, ±10%	
C-251	21291-21	Same as C-106	
C-252	21291-21	Same as C-106	
C-253	21201-100	Ceramic Tub., 500 V., 10 micromicrofarads, ±1.0 micromicrofarads	
C-254	21291-21	Same as C-106	
C-255	21291-21	Same as C-106	
C-256	21291-21	Same as C-106	
C-257	21298-1	Same as C-103	
C-258	21291-21	Same as C-106	
C-259	21291-21	Same as C-106	
C-260	21291-21	Same as C-106	
C-261	21291-6	Same as C-135	
C-262	21298-1	Same as C-103	
C-263	21291-21	Same as C-106	
C-264	24516-229	Same as C-108	
C-265	24516-229	Same as C-108	
C-266	21291-21	Same as C-106	CN-89-A,-B, CNP-89-A,-B.
C-266	21291-5	Same as C-152	CN-89-C,-D CNP-89-C,-D.
C-267	21291-21	Same as C-106	
C-268	21298-1	Same as C-103	
C-301	21201-100	Same as C-253	Early Production
C-301	21201-829	Ceramic Tub., 500V., 8.2μμf, ±0.5μμf, NPO.	Later Production
C-302	21291-21	Same as C-106	
C-303	21201-100	Same as C-253	
C-304	21291-21	Same As C-106	
C-305	24516-689	Same as C-116	
C-306	22019-1	Same as C-109	NAV RCVR RF Output
C-307	24509-688	Ceramic, 500V., 68 micromicrofarads, ±5%	
C-308	22019-1	Same as C-109	NAV RCVR First Mixer Input
C-309	24516-689	Same as C-116	
C-310	24509-828	Ceramic, 500V., .82 micromicrofarads, ±5%	
C-311	21219-18	Ceramic Disc. 500V., 330 micromicrofarads, ±10%	
C-312	21291-4	Same as C-115	
C-313	21291-21	Same as C-106	
C-314	22019-1	Same as C-109	NAV RCVR First Mixer Output
C-315	21201-229	Same as C-205	
C-316	21291-6	Same as C-135	
C-317	23085-113	Same as C-139	
C-318	22001-312	Ceramic Trimmer, 350V., 3-12 mmf, NPO.	NAV Second Mixer Input
C-319	21282-2	Ceramic Tub., 500V., 7.5 micromicrofarads, ±0.5%	
C-320	23085-71	Same as C-124	
C-321	21291-4	Same as C-115	
C-322	21207-120	Ceramic Tub., 12 micromicrofarads, ±10%, N-750	
C-323	21207-120	Same as C-322	
C-324	23085-71	Same as C-124	
C-325	21207-120	Same as C-322	

⟹ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS (Continued)	
C-326	21291-4	Same as C-115	
C-327	23085-79	Mylar, 100V., 22 microfarad, ±10%	
C-328	21207-120	Same as C-322	
C-329	21291-14	Same as C-226	
C-330	21291-14	Same as C-226	
C-331	23085-79	Same as C-327	
C-332	23085-79	Same as C-327	
C-333	24049-150	Dipped Mica, 500 V., 15 micromicrofarads, ±1.0 micromicrofarad	
C-334	24049-750	Same as C-327	NAV RCVR HFO Output
C-335	22019-1	Same as C-109	NAV RCVR HFO Output
C-336	21291-21	Same as C-106	
C-337	21298-1	Same as C-103	
C-338	21298-1	Same as C-103	
C-339	21291-6	Same as C-135	
C-340	21299-470	Ceramic Tub., 500V., 47 micromicrofarads, ±10%	
C-341	24049-431	**Dipped Mica, 500V., 430 micromicrofarads, ±5% micromicrofarad**	
C-342	24045-122	Dipped Mica, 500V., 1200 micromicrofarads	
C-343	21206-330	Ceramic Tub., 500V., 33μμf, ±10%, N-470	CN-89-A,-B CNP-89-A,-B
C-343	21294-330	Ceramic Tub., 500V., 33μμf, ±10%, N-1500	CN-89-C,-D CNP-89-C,-D
C-344	24517-1	Feed Thru, 500V., 100 micromicrofarads, ± 10%	
C-345	22001-312	Same as C-318	
C-346	21201-330	Ceramic Tub., 500V., 33μμf, ±10%	
C-346	21201-Sel.	Ceramic Tub., 500V., 33 or 47 micromicrofarads, ±10%	
C-347	21291-21	Same as C-106	
➡ C-347	21291-4	Same as C-115	CN-89-F and later CNP-89-F and later
C-348	21291-21	Same as C-106	CN-89-A CNP-89-A
C-348	23085-151	Same as C-161	CN-89-B,-C,-D CNP-89-B,-C,-D
C-349	21291-21	Same as C-106	
C-350	21298-1	Same as C-103	
C-351	21298-1	Same as C-103	
C-352	21291-21	Same as C-106	
C-353	21298-1	Same as C-103	
C-354	21291-21	Same as C-106	
C-355	21291-21	Same as C-106	
C-356	21291-5	Same as C-152	
C-357	21291-21	Same as C-106	
C-358	21291-21	Same as C-106	
C-359	21282-2	Same as C-319	
C-360	21291-21	Same as C-106	
C-361	21291-21	Same as C-106	
C-362	24516-150	Same as C-148	
C-363	21291-7	Ceramic Disc, 1000V., 470μμf, ±20%	CN-89-C,-D CNP-89-C,-D
➡ C-363	23087-63	Metalized Mylar, 200V., 0.47μf, ±20%	CN-89-F and later CNP-89-E and later
C-364	21291-21	Same as C-106	CN-89-C,-D CNP-89-C,-D
➡ C-365	23085-125	Same as C-160	CN-89-F and later
➡ C-366	21555-18	Solid Tantalum 15V., 22μf	CN-89-F and later CNP-89-E and later
C-401	21552-16	Electrolytic, 3V., 150 microfarads, +150% −10%	
➡ C-401	21554-3	Electrolytic, 15V., 200 microfarads	CNPA-89-D and later CNPB-89-D and later
C-402	21552-17	Electrolytic, 15V., 500 microfarads, Min. Tol.	
C-403	23085-113	Same as C-139	
C-404	21552-3	Electrolytic, 35V., 20 mf, +150% −10%	
C-405	21291-22	Ceramic Disc, 500V., .005 mf, ±10%	
C-406	21552-18	Electrolytic, 15 forward, 5 reverse, 30 mfd, +150% −10%	
➡ C-407	21554-3	Same as C-401	CNPA-89-D and later CNPB-89-D and later
C-501	23085-25	Mylar, 100V., 0.1μf, ±20%	
C-502	21525-23	Electrolytic, 400V., −50 mf, 200V. −100 mf, 200V. −20mf	
C-503	21291-23	Ceramic Disc, 500V., .004mf, ±10%	24 V. Operation
C-503	21291-22	Same as C-405	12 V. Operation
C-504	21291-22	Same as C-503	12 V. Operation
C-504	21291-23	Same as C-503	24 V. Operation
C-505	23085-87	Mylar, 100V., 1.0 mf, ±10%	

➡ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS (Continued)	
C-506	21525-25	Electrolytic, 35V., 500 mf	
C-507	23085-25	Same as C-501	CNPA-89-B CNPB-89-B
C-508	23085-25	Same as C-501	CNPA-89-B CNPB-89-B
		CR, DIODES	
CR-101	75013-5	Diode, Silicon, CD12227 (Similar to 1N459)	CN-89-A,-B,-C,-D CNP-89-A,-B,-C,-D
CR-102	75019-1	Diode, Silicon, 1N914	CN-89-A, CNP-89-A CN-89-B CNP-89-B Early Production
CR-102	75019-2	Diode, Silicon, CD6487	CN-89-A, CNP-89-A CN-89-B, CNP-89-B Later Production
CR-103	75013-4	Diode, Silicon, CD12226 (Similar to 1N457)	CN-89-A,-B,-C,-D CNP-89-A,-B,-C,-D
CR-104	74013-4	Same as CR-103	CN-89-B,-C,-D CNP-89-B,-C,-D
CR-201	75019-2	Same as CR-102	Later Production
CR-301	75019-1	Same as CR-102	NAV RCVR
CR-302	75013-4	Same as CR-103	NAV RCVR
CR-303	75013-4	Same as CR-103	NAV RCVR
CR-501	75204-5	Diode, Silicon, 500 PIV	MOD-PWR Unit
CR-502	75204-5	Same as CR-501	MOD-PWR Unit
CR-503	75204-5	Same as CR-501	MOD-PWR Unit
CR-504	75204-5	Same as CR-501	MOD-PWR Unit
CR-505	75204-5	Same as CR-501	MOD-PWR Unit
CR-506	75204-5	Same as CR-501	MOD-PWR Unit
		F, FUSES	
F-501	66504-12	Fuse, 10A, Slow-Acting Type	12V. MOD-PWR Unit
F-501	66504-10	Fuse, 6-1/4A, Slow-Acting Type	24V. MOD-PWR Unit
		I, LAMPS	
I-101		Lamp No. 53 Red	Panel Illumination
I-102		Lamp, Same as I-101	Panel Illumination
		J, JACKS (CONNECTORS)	
J-101	41110-2	Connector, Chassis, Female	Com. Ant., Panel Unit
J-301	41143-1	Connector, Chassis, Female	Nav. Ant., Panel Unit
J-501	41181-4	Connector, 16 Pin	Power, MP Unit
		K, RELAYS	
K-501	65126-20	Relay, 5 Form C Contacts	T-R Transfer MOD-PWR Unit
		L, INDUCTORS	
L-101	11135-9	Choke	RF Antenna Filter
L-102	11273-26	Coil, Ant. Com. Rec.	
L-103	61378-101	Step Inductor	
L-104	11412-123	Coil, RF Plate, Com.	
L-105	61378-101	Same as L-103	
L-106	11412-129	Coil, Mixer, Comm.	
L-107	61378-101	Same as L-103	
L-108	61406-1	Step Inductor	HF IF COM
L-109	61406-1	Same as L-108	
L-110	61406-1	Same as L-108	
L-111	11138-22	Choke, RF, 18 microhenries, ±10%	
L-112	11135-9	Same as L-101	
L-113	11138-19	Choke, RF, 15 microhenries, ±10%, Insulated	
L-114	11138-9	Choke, RF, 2.2 microhenries	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		L, INDUCTORS (CONTINUED)	
L-201	61378-101	Same as L-103	
L-202	11627-1	Coil, Final Tank	
L-203	11138-9	Same as L-114	
L-204	11138-8	Choke, RF, 1.5 microhenry, ±20%	
L-205	61378-101	Same as L-103	
L-206	11138-9	Same as L-203	
L-207	11412-133	Coil, Second Buffer	
L-208	11138-8	Same as L-204	
L-209	61378-101	Same as L-103	
L-210	11138-11	Choke, RF, 3.3 microhenries, ±10%	
L-211	11412-134	Coil, First Buffer	
L-212	61378-101	Same as L-103	
L-213	11138-4	Choke, RF, 0.33 microhenry, ±20%	
L-214	11412-135	Coil, Mixer	
L-215	11412-132	Coil, Doubler	
L-216	61393-101	Step Inductor Doubler	
L-217	11138-5	Choke, RF, 0.47 microhenry, ±10%	
L-218	11412-112	Coil, HFO	
L-219	61393-101	Same as L-216	
L-220	11138-22	Same as L-111	
L-221	11138-5	Same as L-217	
L-222	11138-5	Same as L-217	
L-223	11138-5	Same as L-217	
L-224	11138-5	Same as L-217	
L-225	11138-5	Same as L-217	CN-89-C,-D CNP-89-C,-D
➙ L-226	11138-5	Same as L-217	CN-89-C CNP-89-C
➙ L-226		Not Used	CN-89-D and later, CNP-89-D and later.
L-227	11138-4	Same as L-213	
L-301	11273-22	Coil, RF	
L-302	61386-1	Step Inductor	
L-303	11138-27	Choke, RF, 0.09 microhenry, ±10%	
L-304	61386-1	Same as L-302	
L-305	11138-27	Same as L-303	
L-306	61386-1	Same as L-302	
L-307	61407-1	Step Inductor, HF IF	
L-308	61407-1	Same as L-307	
L-309	11412-131	Coil, HFO	
L-310	61386-1	Same as L-302	
L-311	11138-2	Choke, RF, 0.15 microhenry, ±20%	
L-312	11359-20	Choke, RF, 39 microhenries, ±10%	
L-313	11138-28	Choke, RF, 0.49 μh., ±5%	CN-89-A,-B CNP-89-A,-B
L-313	11138-5	Choke, RF, insulated, 0.47 μh, ±20%	CN-89-C,-D CNP-89-C,-D
L-314	11273-21	Coil, LFO	
L-315	61384-1	Step Inductor, LFO	
L-316	11138-5	Same as L-217	
L-317	11135-9	Same as L-101	
L-401	11814-2	Inductor, Filter	
L-501	11176-3	Choke, 50 microhenries	
		P, PLUGS (CONNECTORS)	
P-101	41181-3	Connector, 16 Pin Male	Power Circuits, Panel Unit Cable Assy.
	41182-2	Cap, Connector, for P-102 and P-501	Power Circuits, Panel Unit Cable Assy.
P-102	41271-1	Connector, 16 Pin Female	Panel to MP Unit Cable
P-301	41117-1	Connector, 6 Pin Female	Omni Circuits, Panel Unit Cable Assy.
	41130-1	Connector, Male	COM Ant.
	41237-1	Connector, Male	NAV Ant. Cable
	41237-2	Ferrule, for 41237-1	NAV Ant. Cable
P-501	41271-1	Same as P-102	Same as P-102
		Q, TRANSISTORS	
➙ Q-301	75550-2	Transistor, NPN, Silicon, Planar, 2N3391	Audio to M-P Unit, CN-89-F & later, CNP-89-E & later.
Q-401	75510-2	Transistor, Audio Driver	Early Production
Q-401	75534-4	Transistor, Audio Driver	Later Production
Q-402	75510-4	Transistor, Audio Output	24V. Mod-Pwr Unit, Early Production

➙ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
Q-402	75534-3	Transistor, Audio Output	24 V. Mod-Pwr Unit Later Production
Q-403	**75534-3**	Same as Q-402	12V. Mod-Pwr Unit Early Production
Q-403	75534-3	Same as Q-402	12V. Mod-Pwr Unit Later Production
Q-501	**75504-1**	Transistor, DC Power, 2N441	12V. Mod-Pwr Unit
➡ Q-501	**75548-3**	Transistor, DC Power, Special	12V. Mod-Pwr Unit
Q-501	**75505-3**	Transistor, DC Power, 2N174	24 V. Mod-Pwr Unit
Q-502	**75004-1**	Same as Q-501	12V Mod-Pwr Unit
➡ Q-502	**75548-3**	Same as Q-501	12V. Mod-Pwr. Unit
Q-502	**75505-3**	Same as Q-501	24V. Mod-Pwr. Unit
		R, RESISTORS	
R-101	31141-103	Carbon, ½ W, 10K ohms, ±10%	
R-102	31141-473	Carbon, ½ W, 47K ohms, ±10%	
R-103	31141-221	Carbon, ½ W, 220 ohms, ±10%	
R-104	31141-104	Carbon, ½ W, 100K ohms, ±10%	
R-105	31141-104	Same as R-104	
R-106	31141-151	Carbon, ½ W, 150 ohms, ±10%	
R-107	31141-821	Carbon, ½ W, 820 ohms, ±10%	
R-108	31141-104	Same as R-104	
R-109	31141-151	Same as R-106	
R-110	31141-102	Carbon, ½ W, 1K ohms, ±10%	
R-111	31141-151	Same as R-106	
R-112	31141-104	Same as R-104	
R-113	31141-122	Carbon, ½ W, 1.2K ohms, ±10%	CNP-89-A
R-113	31141-471	Carbon, ½ W, 470 ohms, ±10%	CN-89-A, CN-89-B-C-D CNP-89-B-C-D
R-114	31141-151	Same as R-106	
R-115	31141-821	Same as R-107	CNP-89-A
R-115	31141-471	Same as R-113	CN-89-A, CN-89-B, CNP-89-B CNP-89-A
R-116	31141-102	Same as R-110	CNP-89-B,-C,-D CN-89-B,-C,-D
R-117	31141-154	Carbon, ½ W, 150K ohms, ±10%	
R-118	31141-103	Same as R-101	
R-119	31141-474	Carbon, ½ W, 470K ohms ±10%	
R-120	31141-102	Same as R-110	CN-89-A, CNP-89-A
R-120	31141-561	Carbon, ½ W, 560 ohms, ±10%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-121	31141-124	Carbon, ½ W, 120 K ohms, ±10%	
R-122	32040-1	Potentiometer, ½ W, 1 Megohm	CN-89-A, CNP-89-A Volume Control
R-122	32033-1	Potentiometer, ½ W, 1 Megohm	CN-89-B,-C,-D CNP-89-B,-C,-D Volume Control
R-123	31141-823	Carbon, ½ W, 82K ohms, ±10%	
R-124	31141-151	Same as R-106	
R-125	31141-470	Carbon, ½ W, 47 ohms, ±10%	
R-126	31141-103	Same as R-101	
R-127	31141-105	Carbon, ½ W, 1 Megohm, ±10%	
R-128	31141-471	Same as R-305	
R-129	31135-333	Carbon, 1 W, 33 K ohms, ±10%	
R-130	31141-473	Same as R-102	
R-131	31141-104	Same as R-104	
R-132	31141-100	Carbon, ½ W, 10 ohms, ±10%	
R-133	31141-222	Carbon, ½ W, 2.2K ohms, ±10%	CNP-89-A
R-134	31141-473	Same as R-102	CN-89-B,-C,-D CNP-89-B,-C,-D
R-135	31141-395	Carbon, ½ W, 3.9 Megohms, ±10%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-136	31149-333	Carbon, ½ W, 33K ohms, ±5%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-137	31141-395	Same as R-135	CN-89-B,-C,-D CNP-89-B,-C,-D
R-138	32033-1	Part of R-122 Assembly, Pot. 50K ohms	CN-89-B,-C,-D CNP-89-B,-C,-D Squelch Control
R-139	31149-104	Carbon, ½ W, 100K ohms, ±5%	CN-89-B,-C,-D CNP-89-B,-C,-D
R-201	31141-104	Same as R-104	
R-202	31135-472	Carbon, 1 W, 4.7K ohms, ±10%	
R-203	31161-8	Wire-wound, 3 W, 200 ohms, ±5%	
R-204	31141-683	Carbon, ½ W, 68K ohms, ±10%	
R-205	31141-333	Carbon, ½ W, 33K ohms, ±10%	

➡ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		R,RESISTORS (CONTINUED)	
R-206	31135-103	Carbon, 1 W, 10K ohms, ±10%	
R-207	31141-101	Carbon, ½ W, 100 ohms, ±10%	
R-208	31135-221	Carbon, 1 W, 220 ohms, ±10%	
R-209	31141-223	Carbon, ½ W, 22K ohms, ±10%	
R-210	31135-103	Same as R-206	
R-211	31141-101	Same as R-207	
R-212	31141-104	Same as R-104	
R-213	31141-104	Same as R-104	
R-214	31141-101	Same as R-207	
R-215	31141-103	Same as R-101	
R-216	31141-472	Carbon, ½ W, 4.7K ohms, ±10%	
R-217	31141-152	Carbon, ½ W, 1.5K ohms, ±10%	
R-218	31141-473	Same as R-102	
R-219	31141-474	Same as R-119	
R-220	31141-391	Carbon, ½ W, 390 ohms, ±10%	
R-221	31141-104	Same as R-104	
R-222	31135-471	Carbon, 1 W, 470 ohms, ±10%	
R-223	31141-104	Same as R-104	
R-224	31135-333	Same as R-129	CN-89-C,-D CNP-89-C,-D
R-225	31141-223	Same as R-209	
R-226	31141-470	Same as R-125	
R-227	31141-470	Same as R-125	
R-228	31141-479	Carbon, ½ W, 4.7 ohms, ±10%	
⟹ R-229	31141-104	Same as R-104	CN-89-D and later, CNP-89-D and later.
R-301	31141-221	Same as R-103	
R-302	31141-104	Same as R-104	
R-303	31141-151	Same as R-106	
R-304	31141-104	Same as R-104	
R-305	31141-471	Carbon, ½ W, 470 ohms, ±10%	
R-306	31141-151	Same as R-106	
R-307	31141-104	Same as R-104	
R-308	31141-471	Same as R-305	
R-309	31141-151	Same as R-106	
R-310	31141-141	Same as R-106	
R-311	31141-102	Same as R-110	
R-312	31141-685	Carbon, ½ W, 6.8 Megohms, ±10%	
R-313	31141-151	Same as R-106	
R-314	31141-474	Same as R-119	
R-315	31141-474	Same as R-119	
R-316	31141-103	Same as R-101	
R-317	31141-184	Carbon, ½ W, 180K ohms, ±10%	
R-318	32040-2	Potentiometer, ½ W, 1 Meg. ±5%	Volume Control
R-319	31141-105	Same as R-127	
R-320	31141-105	Same as R-127	
R-321	31141-182	Carbon, ½ W, 1.8K ohms, ±10%	
R-322	31141-152	Same as R-217	
R-323	31141-473	Same as R-102	
R-324	31141-479	Same as R-228	
R-325	31141-224	Carbon, ½ W, 220K ohms, ±10%	
R-326	31141-332	Carbon, ½ W, 3.3K ohms, ±10%	
R-327	31135-153	Carbon, 1 W, 15K ohms, ±10%	
R-328	31141-153	Carbon, ½ W, 15K ohms, ±10%	
R-329	31141-102	Same as R-110	
R-330	31141-105	Same as R-127	
R-331	31141-151	Same as R-106	
R-332	31141-473	Same as R-102	
R-333	31141-154	Same as R-117	
R-334	31141-105	Same as R-127	
⟹ R-335	31141-222	Carbon, 2.2KΩ ±10% 1/2W	CN-89-F and later. CNP-89-E and later.
⟹ R-336	31192-222	Carbon, 2.2KΩ ±10% 1/4W	CN-89-F and later. CNP-89-E and later.
⟹ R-337	31192-124	Carbon, 120KΩ ±10% 1/4W	CN-89-F and later. CNP-89-E and later.
⟹ R-338	31192-683	Carbon, 68KΩ ±10% 1/4W	CN-89-F and later. CNP-89-E and later.
⟹ R-339	31141-392	Carbon, 3.9KΩ ±10% 1/2W	CN-89-F and later. CNP-89-E and later.
⟹ R-340	31141-681	Carbon, 680Ω ±10% 1/2W	CN-89-F and later. CNP-89-E and later.
⟹ R-341	31192-105	Carbon, 1MEG, ±10% 1/4W	CN-89-F and later. CNP-89-F and later.

⟹ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		R, RESISTORS (CONTINUED)	
R-401	31141-821	Same as R-107	
R-402	31141-681	Carbon, ½ W, 680 ohms, ± 10%	Early Production
R-402	31141-471	Same as R-113 for CN-89A, CN-89B, CNP-89-B	Later Production
R-403	31179-1	Temp. Sensitive, 0.47 ohm, ± 10% + TC	
R-404	31141-471	Same as R-113	
R-405	31136-270	Carbon, 2W, 27 ohms, ± 10%	
R-406	31135-221	Carbon, 1 W, 220 ohms, ± 10%	12V. Unit
R-406	31135-681	Carbon, 1 W, 680 ohms, ± 10%	24V. Unit
R-407	31141-151	Same as R-106	12V. Unit
R-407	31141-221	Same as R-103	24 Volt Unit
R-408	31141-822	Carbon, ½ W, 8.2K ohms, ± 10%	
R-409	31175-11	Wirewound, 5W, 75 ohms, ± 5%	
R-410	31141-331	Carbon, ½ W, 330 ohms, ± 10%	CN-89-C,-D CNP-89-C,-D
➙ R-411	31135-220	Carbon, 1W, 22 ohms, ± 10%	CNPA-89-D and later.
R-501	31141-180	Carbon, ½ W. 18 ohm, ± 10%	12V MOD-PWR Unit
R-501	31141-101	Same as R-207	24V MOD-PWR Unit
R-502	31136-331	Carbon, 2W, 330 ohm, ± 10%	12V MOD-PWR Unit
R-502	31136-102	Carbon, 2W, 1K ohms, ± 10%	24V MOD-PWR Unit
R-503	31136-331	Same as R-503	12V MOD!PWR Unit
R-503	31136-102	Same as R-502	24V MOD-PWR Unit
R-504	31141-180	Same as R-501	12V MOD-PWR Unit
R-504	31141-101	Same as R-501	24V MOD-PWR Unit
R-505	31135-274	Carbon, 1W, 270K ohms, ± 10%	
R-506	31136-101	Carbon, 2W, 100 ohms, ± 10%	
R-507	31175-11	Same as R-409	
R-508	31141-220	Carbon, ½ W, 22 ohm, ± 10%	For CN-89-A,-B CNP-89-A,-B
R-508	31141-330	Carbon, ½ W, 33 ohms, ± 10%	For CN-89-C-D CNP-89-C-D
R-509	31141-220	Same as R-508 for CN-89-A,-B	
R-510	31141-220	Same as R-508 for CN-89-A,-B	
		S, SWITCHES	
S-101	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A, +DC On-Off
S-101	32033-1	Switch, Part of Assembly R-122	CN-89-B,-C,-D CNP-89-B,-C,-D +DC On-Off
S-102	32040-1	Switch, Part of Assembly R-122	CN-89-A, CNP-89-A Speaker Ground
S-102	32033-1	Switch, Part of Assembly R-122	CN-89-B,-C,-D CNP-89-B,-C,-D Speaker Ground
S-103	61378-101	Switch, Part of L-103	COM RCVR RF Input
➙ S-104	61409-101	Switch, Assembly	CN-89-A and later. CNP-89-A and later.
➙ S-104	61409-101	Switch, Assembly, XTAL Sel., Kc	CN-89-B and later. CNP-89-B and later.
S-105	61378-101	Switch, Part of L-105	COM RCVR RF Output
S-106		Not Used	
S-107	61378-101	Part of L-107	COM RCVR RF Input
S-108	61406-1	Part of L-108	
S-109	61406-1	Part of L-109	
S-110	61406-1	Part of L-110	
S-201	61378-101	Part of L-201	
S-202	61395-1	Switch, XTAL, HFO	COM (Front)
S-203	61396-1	Switch, XTAL, HFO	COM (Rear)
S-204	61391-101	Switch, Part of S-104	
S-205	61378-101	Switch, Part of L-205	
S-206		Not Used	
S-207		Not Used	
S-208		Not Used	
S-209	61378-101	Switch, Part of L-209	
S-210		Not Used	
S-211		Not Used	
S-212	61378-101	Switch, Part of L-212	
S-213		Not Used	
S-214		Not Used	
S-215		Not Used	

➙ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		S, SWITCHES (CONTINUED)	
S-216	61393-101	Switch, Part of L-216	
S-217		Not Used	
S-218		Not Used	
S-219	61393-101	Switch, Part of L-219	
S-220		Not Used	
S-301	61389-1	Switch, XTAL, HFO NAV.	
S-302	61386-1	Switch, Part of L-302	
S-303	61389-1	Same as S-301	
S-304	61386-1	Switch, Part of L-304	
S-305	61388-1	Switch, G/S	
S-306	61386-1	Switch, Part of L-306	
S-307	61407-1	Switch, Part of L-307	
S-308	61407-1	Switch, Part of L-308	
S-309	61385-1	Switch, G/S	
S-310	61386-1	Switch, Part of L-310	
S-311	61387-1	Switch, G/S	
S-312	61387-1	Same as S-311	
S-313	61387-1	Same as S-311	
S-314		Not Used	
S-315	61384-1	Switch, Part of L-315	
		T, TRANSFORMERS	
T-101	11816-102	Transformer, Com RCVR	HF IF Input
T-102	11817-102	Transformer, Com, RCVR	HF IF Input
T-103	11819-102	Transformer, Com. RCVR	LF IF Input & Interstage
T-104	11819-102	Same as T-103	LF IF Output
T-105	11820-102	Transformer, Com	
T-301	11818-102	Transformer, NAV	HF IF
T-302	11815-102	Transformer, NAV	LF IF Input
➡ T-302	11652-102	Transformer, NAV	CN-89-E and later. CNP-89-F and later.
T-303	11822-102	Transformer, NAV	LF IF Output
➡ T-303	11653-102	Transformer, NAV	CN-89-E and later. CNP-89-E and later.
T-401	11821-102	Transformer, Audio Driver	12V. and 24V. Units
T-402	11821-101	Transformer, Audio Output	12V. Unit
T-402	11633-101	Transformer, Audio Output	24V. Unit
T-501	11626-1	Transformer, Power 13.2V	12V. Unit
T-501	11629-1	Transformer, Power 27.5V	24V. Unit
		V, ELECTRON TUBES	
V-101	6BH6	Tube, Electron, Pentode	COM. RCVR RF
V-102	6AK5	Tube, Electron, Pentode	COM. First Mixer
V-103	6EA8	Tube, Electron, Triode Pentode	COM. Second Mixer and COM. Trans LFO
V-104	6BJ6	Tube, Electron, Pentode	COM. First LF IF
V-105	6BJ6	Same as V-104	COM. Second LF IF
V-106	6CW4	Tube, Electron, Triode (Nuvistor)	COM. RCVR LFO
V-201	7551	Tube, Electron, Pentode	Trans. P.A.
V-202	7551	Same as V-201	Trans, Buffer
V-203	8106	Tube, Electron, Tetrode	Trans, RF Amp.
V-204	6AR8	Tube, Electron, Sheet Beam	Trans. Mixer
➡ V-204	75401-1	Tube, Electron, Sheet Beam, Special 6AR8	CN-89-D and later. CNP-89-D and later.
V-205	7587	Tube, Electron, Tetrode (Nuvistor)	COM. Transceiver HFO/Doubler
V-301	6BH6	Same as V-101	NAV RF Amp.
V-302	6CB6	Tube, Electron, Pentode	NAV First Mixer
V-303	6CB6	Same as V-302	NAV Second Mixer
V-304	6BJ6	Same as V-104	NAV LF, IF
V-305	7898	Tube, Electron, Dual Triode	NAV HFO/Audio Cath. Follower
V-306	6CW4	Same as V-106	NAV LFO
		XT, CRYSTALS, QUARTZ, SUBMINIATURE	
XT-101	72007-121	63.2375 Mc, for 117 Whole Mc	COM. Transceiver
XT-102	72007-122	63.7375 Mc, for 118 Whole Mc	COM. Transceiver
XT-103	72007-123	64.2375 Mc. for 119 Whole Mc	COM. Transceiver
XT-104	72007-124	64.7375 Mc. for 120 Whole Mc	COM. Transceiver
XT-105	72007-125	65.2375 Mc. for 121 Whole Mc	COM. Transceiver

➡ Indicates a change or an addition

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		XT, CRYSTALS, QUARTZ, SUBMINIATURE (CON'T)	
XT-106	72007-126	65.7375 Mc, for 122 Whole Mc	COM. Transceiver
XT-107	72007-127	66.2375 Mc. for 123 Whole Mc	COM. Transceiver
XT-108	72007-128	66.7375 Mc. for 124 Whole Mc	COM. Transceiver
XT-109	72007-129	67.2375 Mc. for 125 Whole Mc	COM. Transceiver
XT-110	72007-130	67.7375 Mc, for 126 Whole Mc	COM. Transceiver
XT-111	72007-131	68.2375 Mc, for 127 Whole Mc	COM. Transceiver
XT-112	72007-132	68.7375 Mc, for 128 Whole Mc	COM. Transceiver
XT-113	72007-133	69.2375 Mc, for 129 Whole Mc	COM. Transceiver
XT-114	72007-134	69.7375 Mc, for 130 Whole Mc	COM. Transceiver
XT-115	72007-135	70.2375 Mc, for 131 Whole Mc	COM. Transceiver
XT-116	72007-136	70.7375 Mc, for 132 Whole Mc	COM. Transceiver
XT-117	72007-137	71.2375 Mc, for 133 Whole Mc	COM. Transceiver
XT-118	72007-138	71.7375 Mc, for 134 Whole Mc	COM. Transceiver
XT-119	72007-139	72.2375 Mc, for 135 Whole Mc	COM. Transceiver
XT-120	72007-140	9.475 Mc, for .00 Fractional Mc	COM. Transceiver
XT-121	72007-141	9.425 Mc, for .05 Fractional Mc	COM. Transceiver
XT-122	72007-142	9.375 Mc, for .10 Fractional Mc	COM. Transceiver
XT-123	72007-143	9.325 Mc, for .15 Fractional Mc	COM. Transceiver
XT-124	72007-144	9.275 Mc, for .20 Fractional Mc	COM. Transceiver
XT-125	72007-145	9.225 Mc, for .25 Fractional Mc	COM. Transceiver
XT-126	72007-146	9.175 Mc, for .30 Fractional Mc	COM. Transceiver
XT-127	72007-147	9.125 Mc, for .35 Fractional Mc	COM. Transceiver
XT-128	72007-148	9.075 Mc, for .40 Fractional Mc	COM. Transceiver
XT-129	72007-149	9.025 Mc, for .45 Fractional Mc	COM. Transceiver
XT-130	72007-150	8.975 Mc, for .50 Fractional Mc	COM. Transceiver
XT-131	72007-151	8.925 Mc, for .55 Fractional Mc	COM. Transceiver
XT-132	72007-152	8.875 Mc, for .60 Fractional Mc	COM. Transceiver
XT-133	72007-153	8.825 Mc, for .65 Fractional Mc	COM. Transceiver
XT-134	72007-154	8.775 Mc, for .70 Fractional Mc	COM. Transceiver
XT-135	72007-155	8.725 Mc, for .75 Fractional Mc	COM. Transceiver
XT-136	72007-156	8.675 Mc, for .80 Fractional Mc	COM. Transceiver
XT-137	72007-157	8.625 Mc, for .85 Fractional Mc	COM. Transceiver
XT-138	72007-158	8.575 Mc, for .90 Fractional Mc	COM. Transceiver
XT-139	72007-159	8.525 Mc, for .95 Fractional Mc	COM. Transceiver
XT-140	72007-160	96.550 Mc, for 108 Whole Mc	NAV Receiver
XT-141	72007-161	97.550 Mc, for 109 Whole Mc	NAV Receiver
XT-142	72007-162	98.550 Mc, for 110 Whole Mc	NAV Receiver
XT-143	72007-163	99.550 Mc, for 111 Whole Mc	NAV Receiver
XT-144	72007-164	100.550 Mc, for 112 Whole Mc	NAV Receiver
XT-145	72007-165	101.550 Mc, for 113 Whole Mc	NAV Receiver
XT-146	72007-166	102.550 Mc, for 114 Whole Mc	NAV Receiver
XT-147	72007-167	103.550 Mc, for 115 Whole Mc	NAV Receiver
XT-148	72007-168	104.550 Mc, for 116 Whole Mc	NAV Receiver
XT-149	72007-169	105.550 Mc, for 117 Whole Mc	NAV Receiver
	EL-2051	KIT, Crystals, 90 to 360 Ch. Conversion	For COM Transceiver
		MISCELLANEOUS (No Symbol)	
None	41147-3	Socket, Pilot Light, One Insulated Terminal	For I-101, Panel Lamp
None	41225-2	Socket, Pilot Light, Two Insulated Terminals	For I-102, Panel Lamp
None	42015-5	Base, Tube Shield	V-203
	42033-5	Tube Socket, 7 Pin	All 7 pin min. tubes
None	42034-3	Tube Socket, 9 Pin	V-103
None	42034-6	Tube Socket, 9 Pin	V-305
None	42051-1	Tube Shield, Telescoping	V-103,204,305
None	42051-2	Tube Shield, Telescoping, Black	V-202
None	42060-4	Tube Socket, 9 Pin, Recessed	V-201,202,203,204

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		MISCELLANEOUS (No Symbol) (CON'T)	
None	42061-1	Socket, Nuvistor	All Nuvistor Tubes
None	42064-1	Socket, Transistor	MOD-PWR Unit, All Transistors
None	52085-101	Mounting Base	For T12MP12 or T24MP12
None	54451-1	Crystal Holder	COM Mc
None	54514-1	Spring, Grounding	Panel Unit
None	54855-1	Spring, Plate, Cap	Nuvistor
None	55020-2	Insulator, Transistor	For Q-401
None	55520-1	Crystal Holder	NAV. Mc
None	55766-1	Bushing, Knob	NAV. Mc.
None	56404-2	Mask	Panel Unit
None	56409-1	Cover, Top Osc.	NAV. Receiver
None	56410-1	Cover, Bottom Osc.	NAV. Receiver
None	56414-101	Case Assembly	Panel Unit
None	56425-1	Cover, Top Osc.	COM.
None	56426-1	Cover, Bottom Osc.	COM.
None	56438-1	Cover, Dust	MOD-PWR Unit, Two required
None	56443-101	Panel Trim	Panel Unit
None	56446-1	Cover, Amp	COM. R.F. Output
None	61377-1	Detent, Adjustable	NAV. Kc
None	61401-1	Detent, Roller	COM. Kc
None	61402-1	Detent, Spring	COM. Kc
None	61404-101	Assembly, Detent Roller	COM- Kc
None	66507-1	Fuse Holder	MOD-PWR Unit
None	81312-1	Washer, Curved Spring	Case Fastener
None	81330-3	Washer, Shoulder	For Mod-Pwr Unit, Q-401
None	81621-2	Bushing, Knob	NAV. Kc
None	81622-3	Clip, Tube Pin Type	For Mod-Pwr Unit, Q-401,Q-402, Q-
None	81677-11	Nut, Special, Hex	Ground Contact Support
None	84067-3	Stud, Southco (Wing)	Case Fastener
None	84069-1	Receptacle, Southco	Case Fastener
None	84071-1	Hairpin Retainer	Case Fastener
None	84071-2	Cotter, Hair Pin	Panel Unit, Nav. Mc Assy.
None	88111-102	Assembly, Dial	COM. Kc
None	88111-105	Assembly Dial	NAV. Kc
None	88129-2	Knob	Volume Control
None	88132-101	Assembly, Knob	COM. Mc
None	88145-101	Assembly, Knob	NAV. Mc
None	88146-3	Knob	COM. Kc
None	88146-4	Knob	NAV. Kc
None	88148-2	Knob	Squelch Control
None	90617-2	Cable only, two branches, no Connectors	For CN-89 Chassis
None	90618-96	Cable, Mod-Pwr and Accessory, 8' Long	Interconnections
None	90618-190	Cable, Mod-Pwr and Accessory, 16' Long	Interconnections
None	EL-2053	Cable, Glide Slope Switching	Interconnections

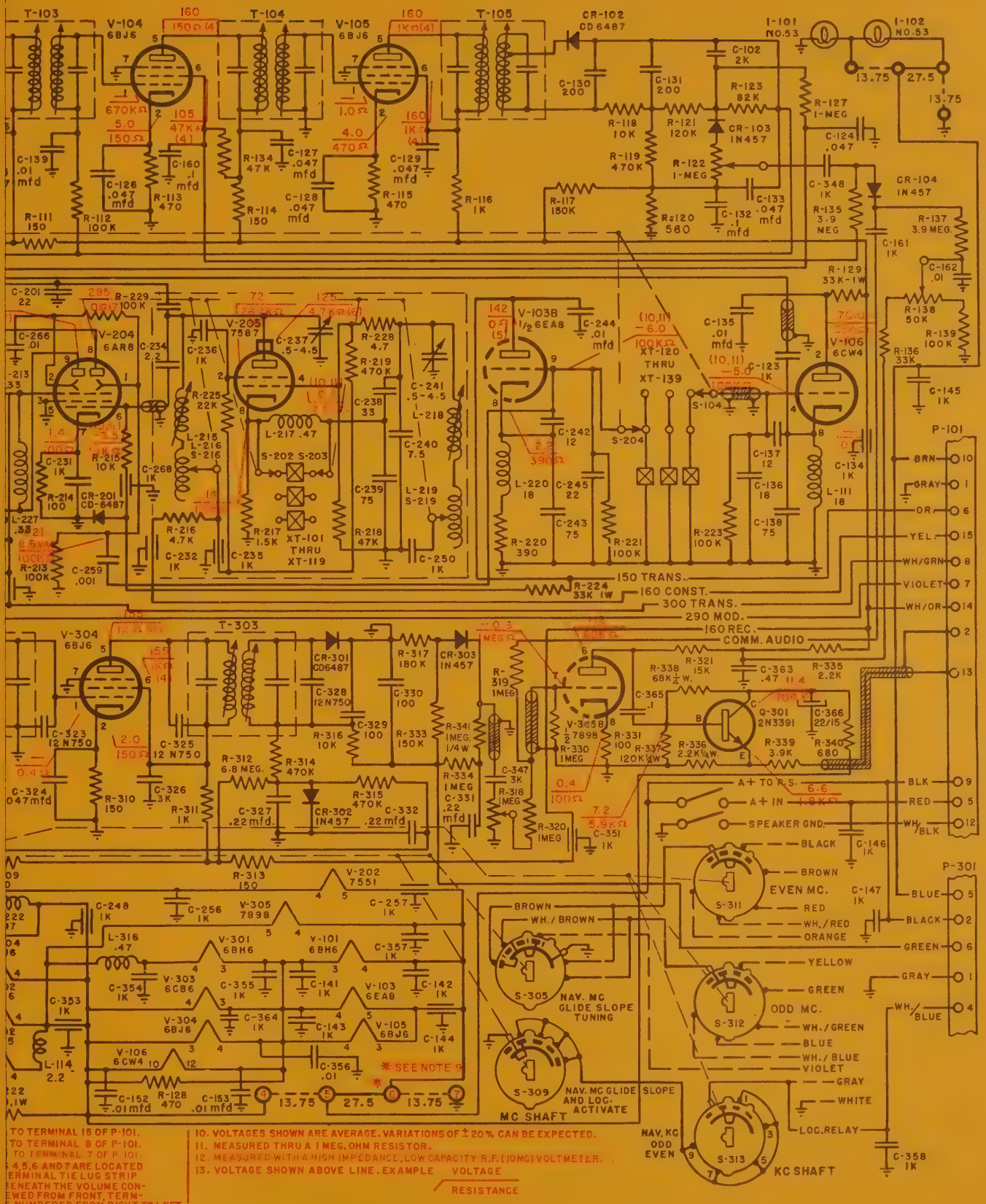


Figure 11c.
SCHEMATIC, ***narco*** Mark -12, PANEL UNIT
For CN89-E & F and CNP89-E & F.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		MISCELLANEOUS (No Symbol) (CON'T)	
None	42061-1	Socket, Nuvistor	All Nuvistor Tubes
None	42064-1	Socket, Transistor	MOD-PWR Unit, All Transistors
None	52085-101	Mounting Base	For T12MP12 or T24MP12
None	54451-1	Crystal Holder	COM Mc
None	54514-1	Spring, Grounding	Panel Unit
None	54855-1	Spring, Plate, Cap	Nuvistor
None	55020-2	Insulator, Transistor	For Q-401
None	55520-1	Crystal Holder	NAV. Mc
None	55766-1	Bushing, Knob	NAV. Mc.
None	56404-2	Mask	Panel Unit
None	56409-1	Cover, Top Osc.	NAV. Receiver
None	56410-1	Cover, Bottom Osc.	NAV. Receiver
None	56414-101	Case Assembly	Panel Unit
None	56425-1	Cover, Top Osc.	COM.
None	56426-1	Cover, Bottom Osc.	COM.
None	56438-1	Cover, Dust	MOD-PWR Unit, Two required
None	56443-101	Panel Trim	Panel Unit
None	56446-1	Cover, Amp	COM. R.F. Output
None	61377-1	Detent, Adjustable	NAV. Kc
None	61401-1	Detent, Roller	COM. Kc
None	61402-1	Detent, Spring	COM. Kc
None	61404-101	Assembly, Detent Roller	COM- Kc
None	66507-1	Fuse Holder	MOD-PWR Unit
None	81312-1	Washer, Curved Spring	Case Fastener
None	81330-3	Washer, Shoulder	For Mod-Pwr Unit, Q-401
None	81621-2	Bushing, Knob	NAV. Kc
None	81622-3	Clip, Tube Pin Type	For Mod-Pwr Unit, Q-401,Q-402, Q-
None	81677-11	Nut, Special, Hex	Ground Contact Support
None	84067-3	Stud, Southco (Wing)	Case Fastener
None	84069-1	Receptacle, Southco	Case Fastener
None	84071-1	Hairpin Retainer	Case Fastener
None	84071-2	Cotter, Hair Pin	Panel Unit, Nav. Mc Assy.
None	88111-102	Assembly, Dial	COM. Kc
None	88111-105	Assembly Dial	NAV. Kc
None	88129-2	Knob	Volume Control
None	88132-101	Assembly, Knob	COM. Mc
None	88145-101	Assembly, Knob	NAV. Mc
None	88146-3	Knob	COM. Kc
None	88146-4	Knob	NAV. Kc
None	88148-2	Knob	Squelch Control
None	90617-2	Cable only, two branches, no Connectors	For CN-89 Chassis
None	90618-96	Cable, Mod-Pwr and Accessory, 8' Long	Interconnections
None	90618-190	Cable, Mod-Pwr and Accessory, 16' Long	Interconnections
None	EL-2053	Cable, Glide Slope Switching	Interconnections

A. INTRODUCTION.

The Panel Unit Schematic in this supplement is concerned primarily with two changes:

1. The NAV Receiver L.F.-I.F. has been changed from 1.425 Mc to 1.125 Mc.
2. An emitter follower COM/NAV Audio output Amplifier (Q-301) has been added.

Other minor changes in both the panel and Modulator-Power Units have been made to improve the operation of current production equipments.

NOTE:

Because of a lack of space the functions of S-311 and S-312, near the lower right of Fig. 11b. on this sheet, are not fully stated.

S-311 "EVEN MC" means: "EVEN whole Mc Channels (108 Mc. or 110 Mc.) associated with the ODD Kc. (Fractional Mc.) Channels .1, .3, .5, .7, .9 Mc."

S-312 'ODD MC" means: "ODD whole Mc. Channels (109 Mc. or 111 Mc.) associated with the ODD Kc. (Fractional Mc.) Channels .1, .3, .5, .7, .9 Mc."

B. SCHEMATICS.

Figure 11c., Page 111 Extension, Panel Unit.
Figure 12b., Page 113 Extension, 12V. MP Unit.
Figure 13b., Page 115 Extension, 24V. MP Unit.

narco MARK-12
MM-211, Supplement No. 3

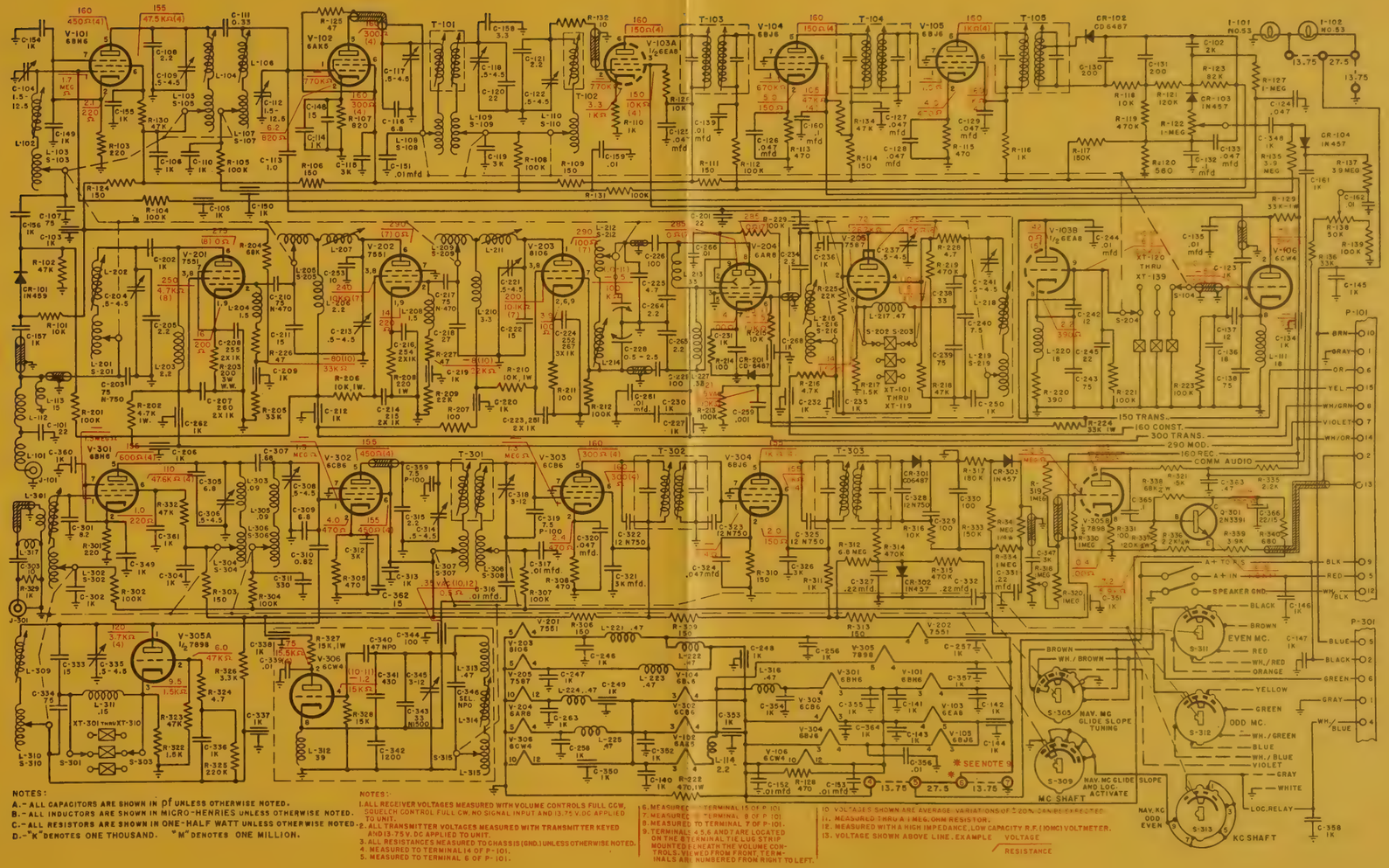

NOTES:
A.-ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
B.-ALL INDUCTORS ARE SHOWN IN MICRO-HENRIES UNLESS OTHERWISE NOTED.
C.-ALL RESISTORS ARE SHOWN IN ONE-HALF WATT UNLESS OTHERWISE NOTED.
D.-"K" DENOTES ONE THOUSAND. "M" DENOTES ONE MILLION.
NOTES:
1. ALL RECEIVER VOLTAGES MEASURED WITH VOLUME CONTROLS FULL CCW, SQUELCH CONTROL FULL CW, NO SIGNAL INPUT AND 13.75 V.DC APPLIED TO UNIT.
2. ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V. DC APPLIED TO UNIT.
3. ALL RESISTANCES MEASURED TO CHASSIS (GND.) UNLESS OTHERWISE NOTED.
4. MEASURED TO TERMINAL 14 OF P-101.
5. MEASURED TO TERMINAL 8 OF P-101.
6. MEASURED TERMINAL 15 OF P-101
7. MEASURED TERMINAL 8 OF P-101
8. MEASURED TO TERMINAL 7 OF P-101
9. TERMINALS 4,5,6 AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS. VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.
10. VOLTAGES SHOWN ARE AVERAGE VARIATIONS OF ± 20% CAN BE EXPECTED.
11. MEASURED THRU A 1 MEG. OHM RESISTOR.
12. MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10MC) VOLTMETER.
13. VOLTAGE SHOWN ABOVE LINE, EXAMPLE - VOLTAGE / RESISTANCE
EVEN MC.
ODD MC.
NAV. MC GLIDE SLOPE TUNING
MC SHAFT
KC SHAFT
SPEAKER GND.
LOC. RELAY
SEE NOTE 9

Figure 11c.
SCHEMATIC, *narco* Mark -12, PANEL UNIT
For CN89-E & F and CNP89-E & F.

Ref. T-02206-B 2-19-65 ECN-4484

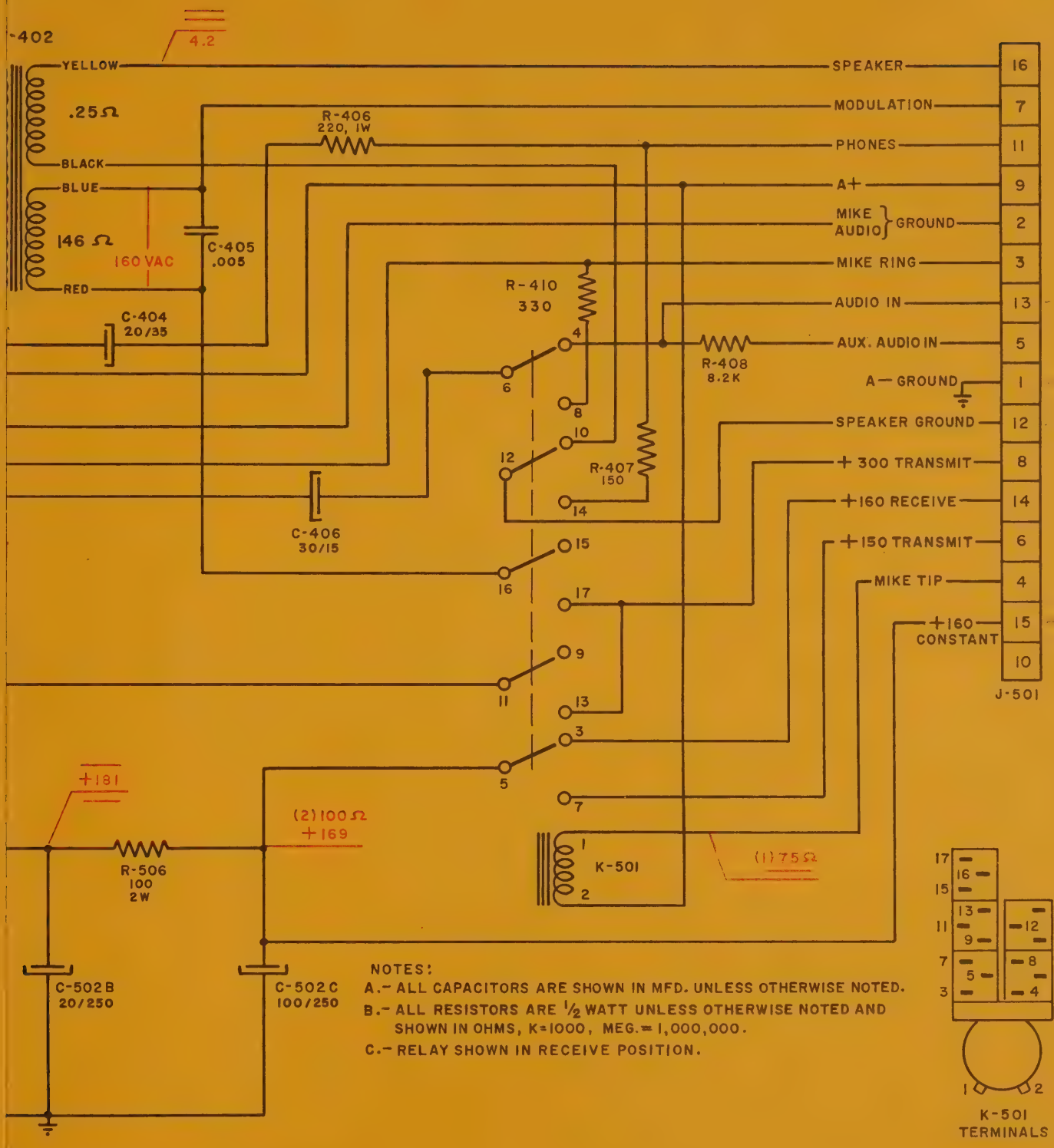
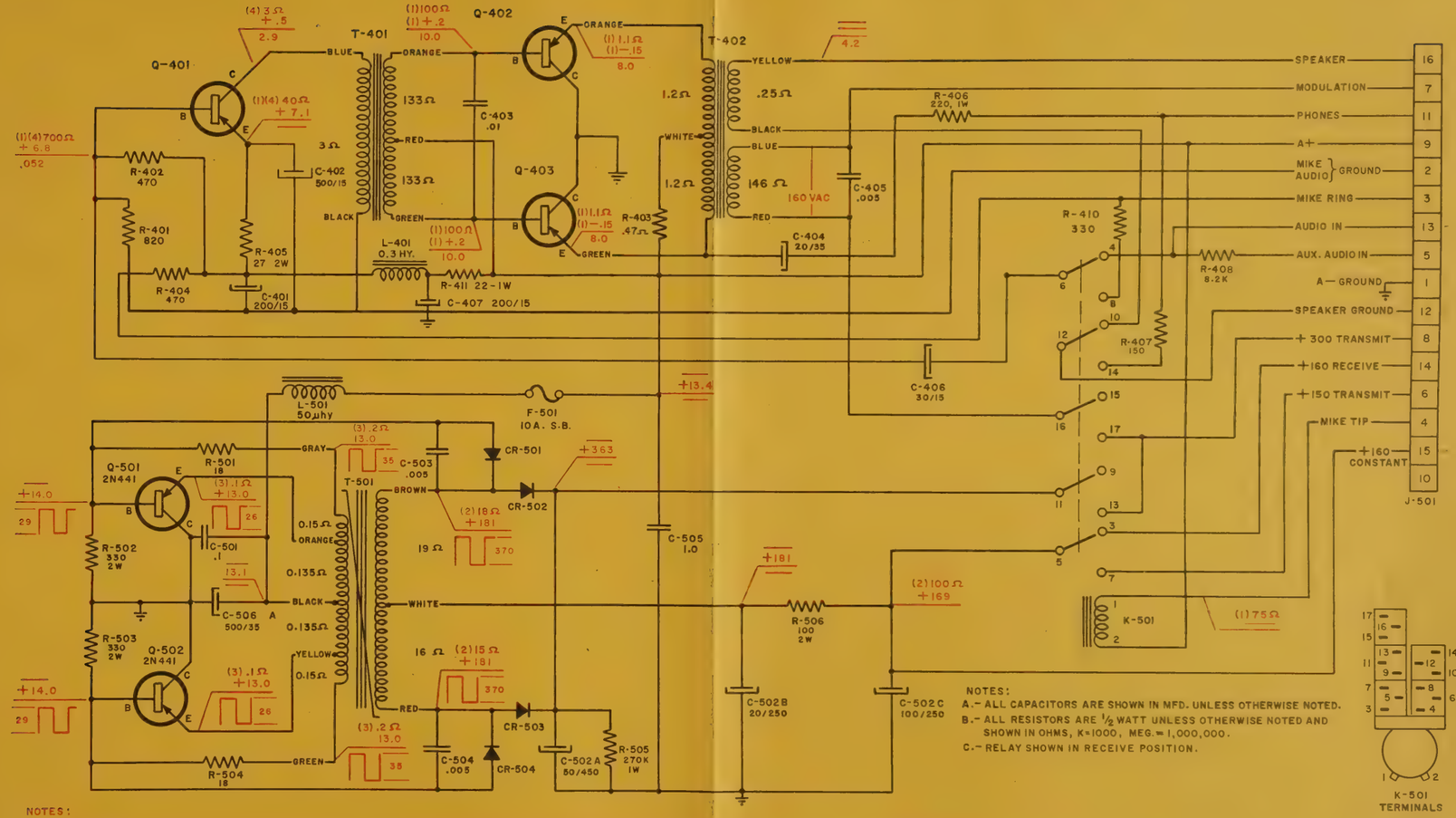


Figure 12b.
SCHEMATIC, MODULATOR POWER UNIT, T-12MP-12,
for *narco* Mark-12 operation on 12 Volts.
CNPA89-C & D

narco MARK-12
MM-211, Supplement No. 3



NOTES:
(1) - MEASURED WITH RESPECT TO A +, PIN-9.
(2) - MEASURED WITH RESPECT TO WHITE LEAD OF T-501.
(3) - MEASURED WITH RESPECT TO BLACK LEAD OF T-501.
(4) - MEASURED WITH Q-401 REMOVED.

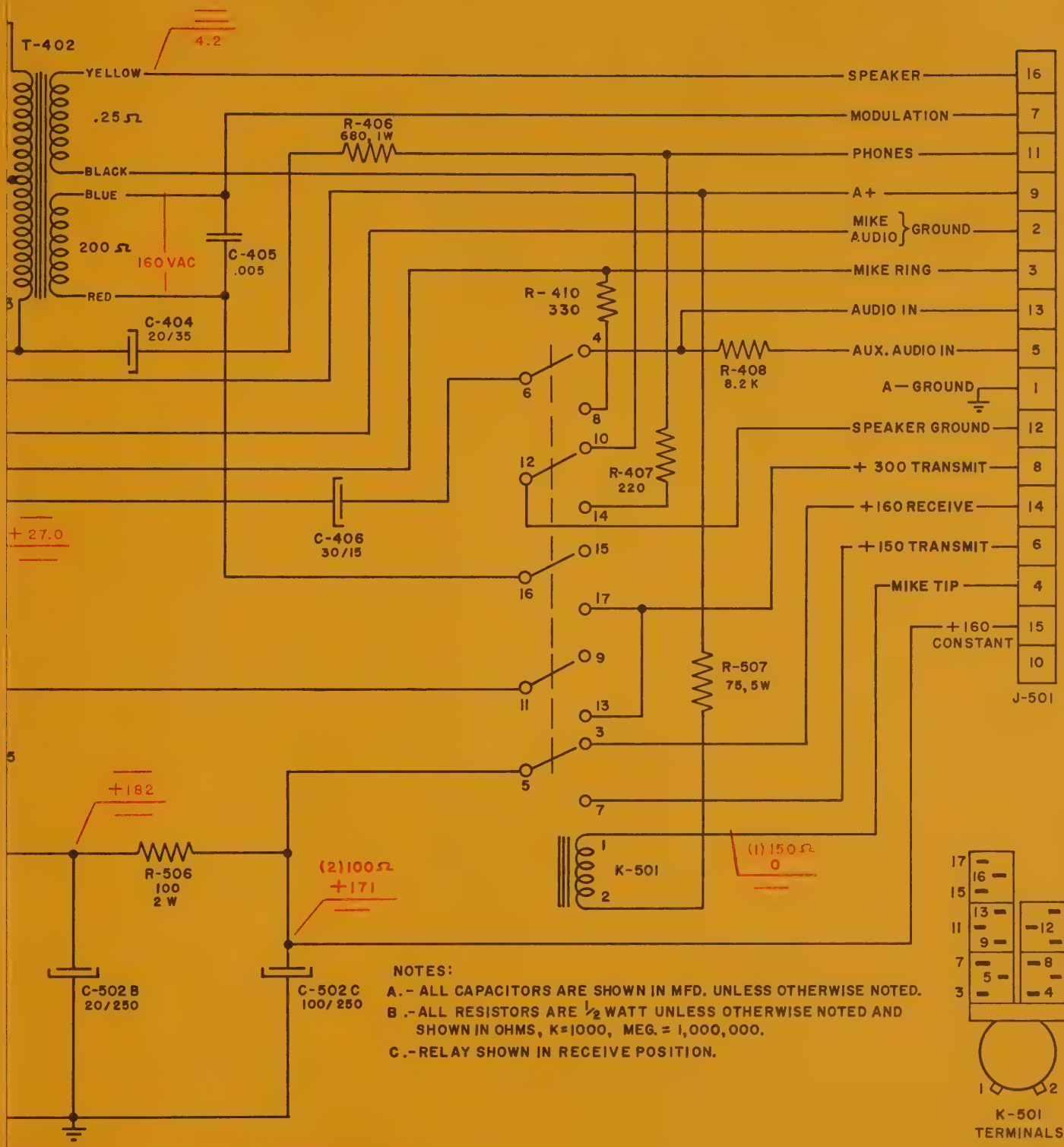
RESISTANCE READING TAKEN WITH CONNECTOR DISCONNECTED.
OTHER READINGS ARE TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS OF AUDIO OUT, WITH NORMAL 13.75 V. INTO POWER CABLE AT MARK-12. (AUDIO FREQUENCY 1000 CYCLES)
ALL DC MEASUREMENTS ARE WITH RCA VOLTOHMIST VTVM OR EQUIVALENT.
ALL WAVEFORMS ARE MEASURED WITH A DUMONT 401B OSCILLOSCOPE OR EQUIVALENT.
ALL AC MEASUREMENTS WITH BALLANTINE AC VOLTMETER OR EQUIVALENT.

TEST DATA LINE
RESISTANCE
DC VOLTAGE AND POLARITY
AC VOLTAGE OR WAVE SHAPE & P-P VOLTAGE

NOTES:
A.— ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.— ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.
C.— RELAY SHOWN IN RECEIVE POSITION.

Figure 12b.
SCHEMATIC, MODULATOR POWER UNIT, T-12MP-12,
for *narco* Mark-12 operation on 12 Volts.
CNPA89-C & D

Ref. T-02178-L 12-14-64 ECN-4443



NOTES:
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG. = 1,000,000.
C.- RELAY SHOWN IN RECEIVE POSITION.

CONNECTED.
OPERATION AND
), WITH NORMAL
VTVM OR
OIB OSCILLOSCOPE
LTMETER OR

TEST DATA LINE
RESISTANCE
DC VOLTAGE AND POLARITY
AC VOLTAGE OR
WAVE SHAPE & P-P VOLTAGE

Figure 13b.
SCHEMATIC, MODULATOR POWER UNIT T-24MP-12
for *narco* Mark-12 operation on 24 Volts.
CNPB89-C & D

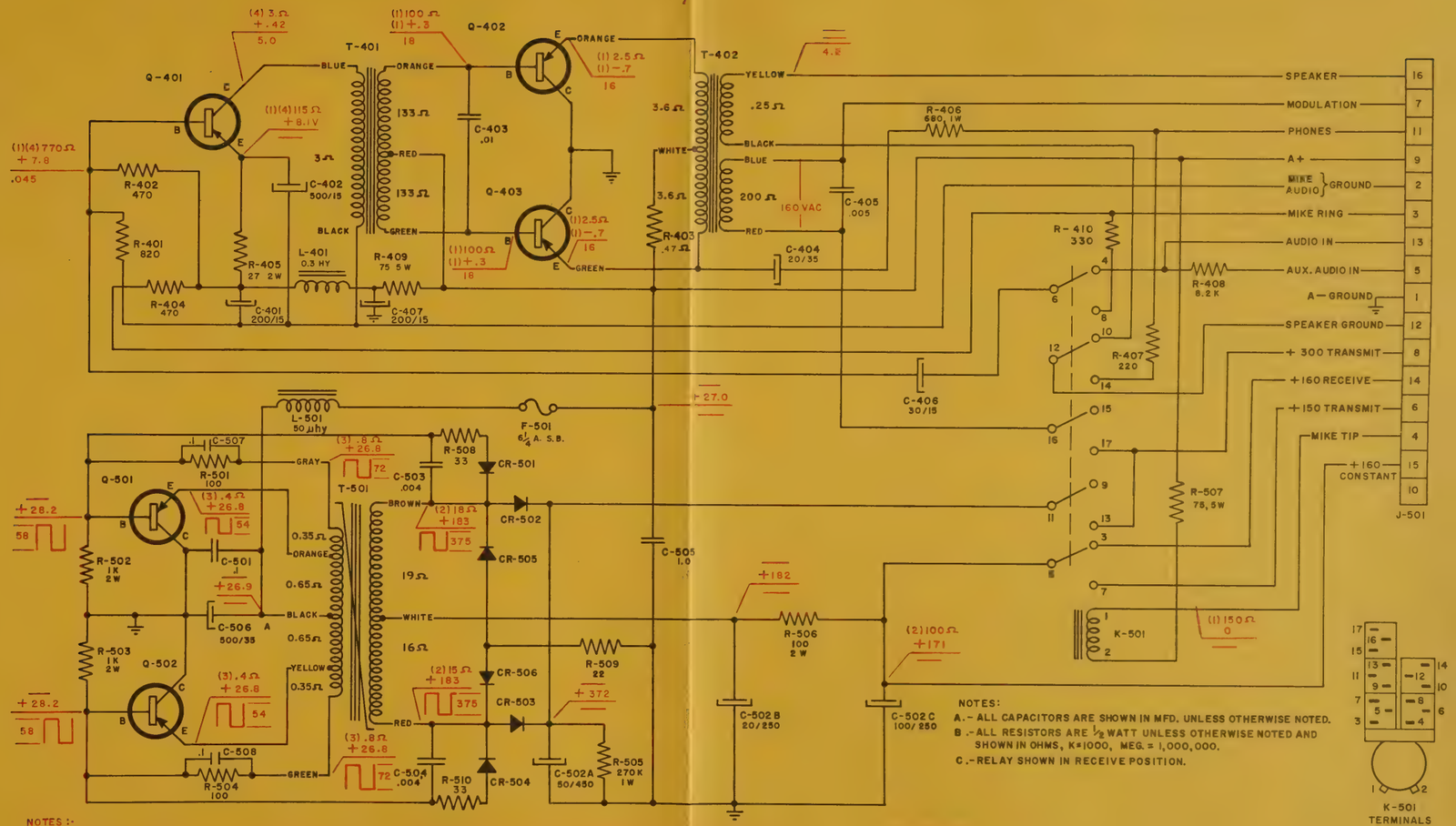


Figure 13b.
SCHEMATIC, MODULATOR POWER UNIT T-24MP-12
for *narco* Mark-12 operation on 24 Volts.
CNPB89-C & D

Ref. T-02183-E 12-14-64 ECN-4443

narco MARK-12
MM-211, Supplement No. 3

MARK-12
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12 or T24MP-12 MODULATOR-POWER UNIT

MAINTENANCE MANUAL

SUPPLEMENT No. 4

FOR PANEL UNITS:

CN89-G.
CNP89-G.

INTRODUCTION

This supplement is concerned with a change in the balanced mixer (V-204) output circuit.

CONTENTS

Schematic ..... Page 119

CHANGES

C-225 Deleted.
C-226 Deleted and replaced by bus wire.
C-229 Deleted and replaced by bus wire.
L-213 Changed from 0.33 μh to 2.2 μh. Part No. is now ***narco*** 11138-9.
L-214 A link coupling winding was added. Part No. is now ***narco*** 11412-136.
L-227 Deleted.
R-212 Deleted.

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FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

3075-600
Supplement No. 4

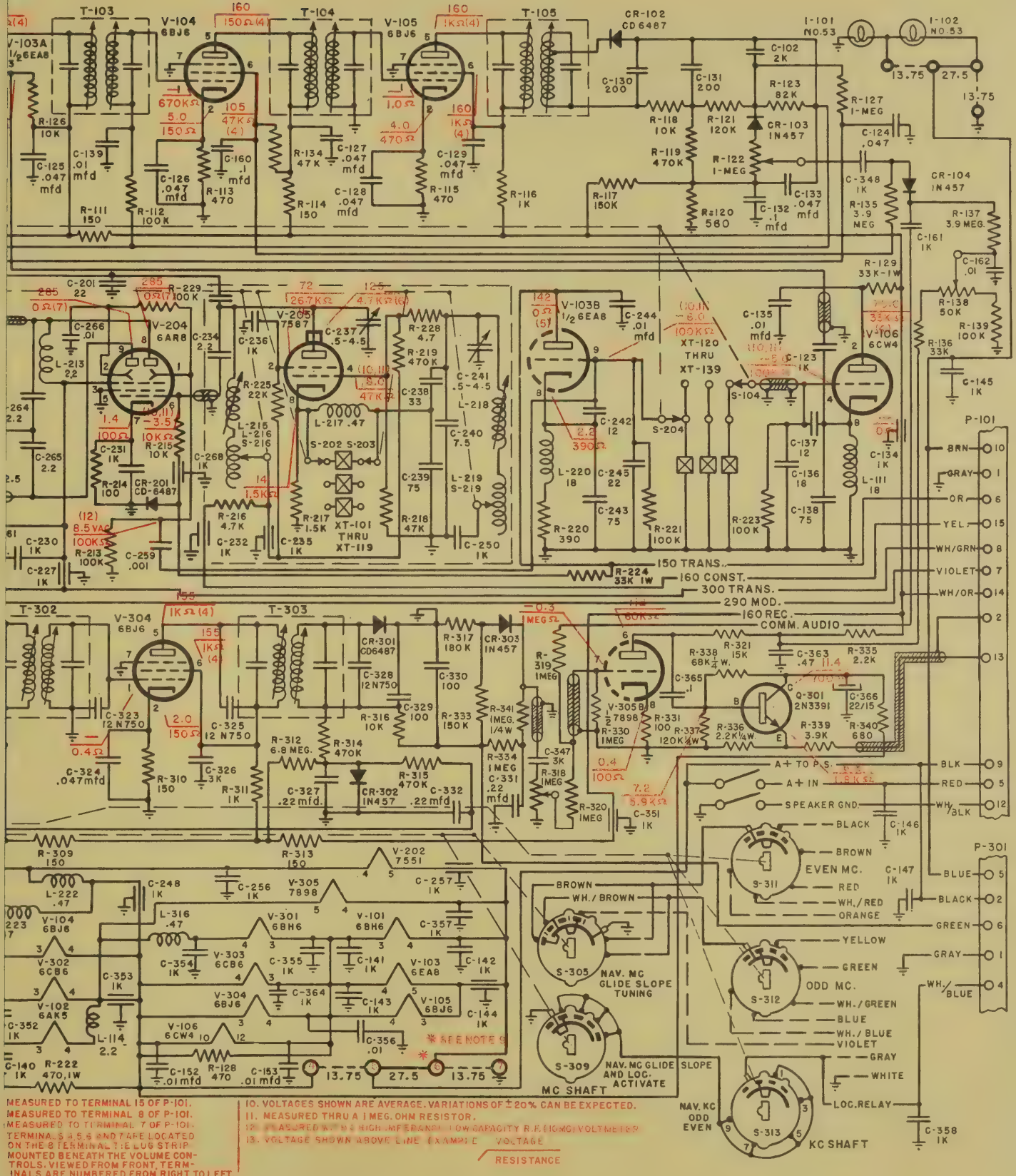

Figure 11d.
SCHEMATIC, ***narco*** Mark-12, PANEL UNIT
For CN89-G and CNP89-G.

A. INTRODUCTION.

The Panel Unit Schematic in this supplement is concerned primarily with a change in the balanced mixer (V-204) output circuit. For details see the cover sheet, page 117.

NOTE:

Because of a lack of space the functions of S-311 and S-312, near the lower right of Fig. 11d. on this sheet, are not fully stated.

S-311 "EVEN MC" means: "EVEN whole Mc Channels (108 Mc. or 110 Mc.) associated with the ODD Kc. (Fractional Mc.) Channels .1, .3, .5, .7, .9 Mc."

S-312 "ODD MC" means: "ODD whole Mc. Channels (109 Mc. or 111 Mc.) associated with the ODD Kc. (Fractional Mc.), Channels .1, .3, .5, .7, .9 Mc.

narco MARK-12
MM-211, Supplement No. 4

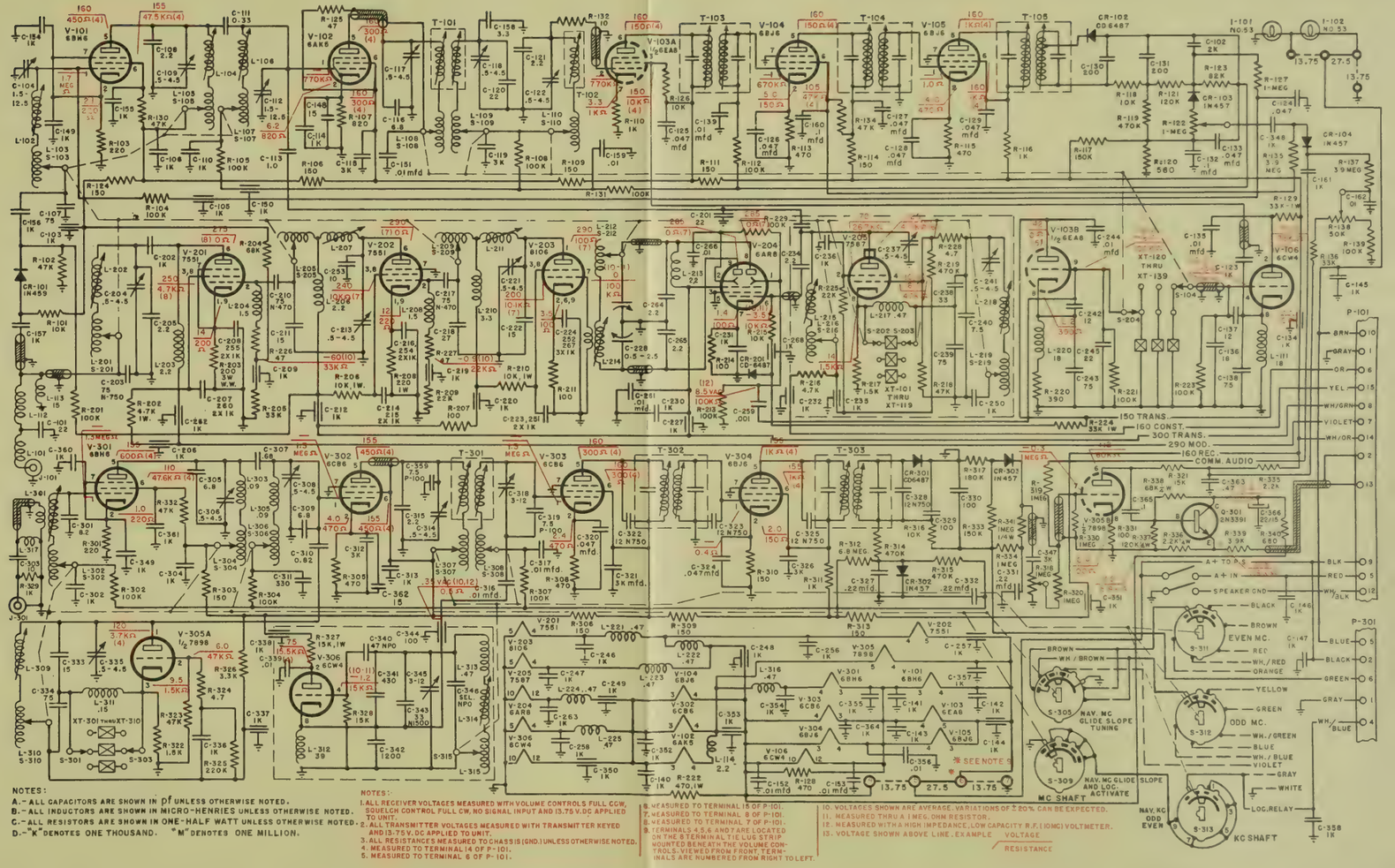
NOTES:
A.- ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
B.- ALL INDUCTORS ARE SHOWN IN MICRO-HENRIES UNLESS OTHERWISE NOTED.
C.- ALL RESISTORS ARE SHOWN IN ONE-HALF WATT UNLESS OTHERWISE NOTED.
D.-"K" DENOTES ONE THOUSAND. "M" DENOTES ONE MILLION.
NOTES:
1. ALL RECEIVER VOLTAGES MEASURED WITH VOLUME CONTROLS FULL CCW, SQUELCH CONTROL FULL CW, NO SIGNAL INPUT AND 13.75 V.DC APPLIED TO UNIT.
2. ALL TRANSMITTER VOLTAGES MEASURED WITH TRANSMITTER KEYED AND 13.75 V. DC APPLIED TO UNIT.
3. ALL RESISTANCES MEASURED TO CHASSIS (GND.) UNLESS OTHERWISE NOTED.
4. MEASURED TO TERMINAL 14 OF P-101.
5. MEASURED TO TERMINAL 6 OF P-101.
6. MEASURED TO TERMINAL 15 OF P-101.
7. MEASURED TO TERMINAL 8 OF P-101.
8. MEASURED TO TERMINAL 7 OF P-101.
9. TERMINALS 4,5,6 AND 7 ARE LOCATED ON THE 8 TERMINAL TIE LUG STRIP MOUNTED BENEATH THE VOLUME CONTROLS. VIEWED FROM FRONT, TERMINALS ARE NUMBERED FROM RIGHT TO LEFT.
10. VOLTAGES SHOWN ARE AVERAGE. VARIATIONS OF ± 20% CAN BE EXPECTED.
11. MEASURED THRU A 1 MEG. OHM RESISTOR.
12. MEASURED WITH A HIGH IMPEDANCE, LOW CAPACITY R.F. (10MC) VOLTMETER.
13. VOLTAGE SHOWN ABOVE LINE, EXAMPLE VOLTAGE / RESISTANCE
* SEE NOTE 9
P-101
P-301
S-311
S-312
S-313
S-305
S-309
MC SHAFT
KC SHAFT
EVEN MC.
ODD MC.
NAV. MC GLIDE SLOPE TUNING
NAV. MC GLIDE SLOPE AND LOC. ACTIVATE
NAV. KC ODD EVEN
LOC. RELAY
COMM. AUDIO
150 TRANS.
160 CONST.
300 TRANS.
290 MOD.
160 REC.
SPEAKER GND
A+ IN
A+ TO P-5
BLACK
BROWN
RED
ORANGE
YELLOW
GREEN
BLUE
VIOLET
GRAY
WHITE
WH./BLUE
WH./GREEN
WH./RED
WH./BRN
XT-120 THRU XT-139
XT-301 THRU XT-310
XT-101 THRU XT-119

Figure 11d.
SCHEMATIC, *narco* Mark-12, PANEL UNIT
For CN89-G and CNP89-G.
- 119 - Extension

How are we doing?

We at Narco welcome your comments and suggestions about the manuals, both good and bad. These are the best indicators of how informative the manual is to you, the ultimate user.

Should you have a helpful addition or find something that appears to be an error — fill in this slip and mail it right to the Technical Pubs Dept. and upon evaluation, we'll adjust the manual to include it.

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MARK 12A
VHF Transceiver

with

NAVIGATION RECEIVER

and

T12MP-12A or T24MP-12A MODULATOR-POWER UNIT

MAINTENANCE MANUAL

for

CN144-A
CNPA144-A
CNPB144-A

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

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April, 1966

3077-600

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SECTION 1
INTRODUCTION

1-A. INTRODUCTION.

The ***narco*** Mark 12A is a combination VHF communication transceiver and a wholly independent VHF navigation receiver using advanced circuit techniques for high reliability. The panel unit contains the communication transceiver and navigation receiver sections, while the remotely-located modulator-power unit contains the audio and power sections.

The Mark 12A incorporates a NAV ident filter, continuous NAV receiver operation while transmitting. The Mark 12A panel unit and modulator/power unit, however, are interchangeable with their Mark 12 counterparts.

1-A,1. Panel Unit.

The VHF Transceiver is designed to be used as a primary communications apparatus. It is controlled by the left hand frequency selector of the Panel Unit. It is available with either 90 or 360 crystal controlled channels. A kit of crystals, obtainable from ***narco***, can be installed at any time to convert a 90-channel Mark 12A for operation on 360 channels. Both receiver and transmitter are controlled by the same channel selector.

A 100 channel VHF Navigation Receiver is controlled by the right hand frequency selector. Used with an omni converter it can provide complete VOR/LOCALIZER navigation. An IDENT filter eliminates the code identification from a NAV signal so voice communications can be clearly understood. Pulling the NAV volume control knob disables the filter to permit positive identification of the station. The navigation receiver is not cut off while transmitting. Omni or localizer signals are therefore available at all times. This feature is especially desirable if an autopilot is coupled to the omni converter.

The navigation receiver contains glide slope and DME channel selector switches. Cable and connector kits may be installed at any time to connect these switches to a glide slope receiver, a DME interrogator, or both.

1-A,2. Modulator-Power Unit.

A remote-mounted Unit, the T12MP-12A or T24MP-12A, contains the power supply and audio-modulator. An auxiliary audio input circuit is provided so that one or more other radio equipments may be connected to operate through the ***narco*** Mark 12A Audio Amplifier. This audio input circuit is designed for a level of 50 milliwatts from a 300 ohm source.

A gain control in the microphone input may be adjusted for full modulation with inputs of .06 to 1.5 volts from a 100-ohm source. This control is preset at the factory for carbon-microphone levels.

The T12MP-12A and T24MP-12A Units have been designed to be mounted either horizontally or vertically, by means of the mounting base supplied.

1-B. SPECIFICATIONS.

1-B,1. Communication Transceiver.

a. Frequency Range, Domestic Equipment.
   90 Channel Equipment:
   118.0 thru 126.9 Megacycles/Sec.
   (100 Kc Channel Spacing)
   360 Channel Equipment:
   118.00 thru 135.95 Megacycles/Sec.
   (50 Kc Channel Spacing)

b. Frequency Range, Export Equipment.
   100 Channel Equipment:
   117.0 thru 126.9 Megacycles/Sec.
   (100 Kc Channel Spacing)
   380 Channel Equipment:
   117.00 thru 135.95 Megacycles/Sec.
   (50 Kc Channel Spacing)

1-B,2. Communication Transmitter.

Power Output:
Nominal 10 watts.

Sidetone:
50 Milliwatts.

Modulation:
70% minimum at start of limiting.

Frequency Stability:
Maximum ±0.005% over temperature range of –30°C to +55°C, and line voltage range of 10v to 16v (14v unit) or 20v to 32v (28v unit).

Line Voltage: Will operate, capable of intelligible modulation, over line voltage range of 10 to 16v (14v unit) or 20v to 32v (28v unit)

Microphone:
Carbon, noise-cancelling carbon (low impedance), or dynamic with transistor pre-amp. to be used.

Duty:
Maximum 50%. (1 minute on, 1 minute off)

1-B,3. Communication Receiver.

Sensitivity:

1.5 microvolts maximum for 6 db signal + noise to noise ratio.

Overall Selectivity:
6 db (nose), 30 kc/s minimum bandwidth.
60 db (skirt), 90 kc/s maximum bandwidth.

Image Rejection:
At least 60 db.

AVC.
4 db from 10 to 10,000 microvolts.

Audio Output:
6 watts into 4 ohms.

1-B,4. Navigation Receiver.

Frequency Range:
108.0 thru 117.9 Megacycles/Sec.
(100 kc/s Channel Spacing).

Sensitivity:
1.0 microvolt for 6 db signal + noise to noise ratio.

Overall Selectivity:
6 db (nose), 40 kc/s minimum bandwidth.
60 db (skirt), 100 kc/s maximum bandwidth.

Image Rejection:
At least 70 db.

AVC:
4 db from 10 to 10,000 microvolts.

Tone Filter:
Provides 20 db IDENT rejection.

Audio Output:
6 watts into 4 ohms.

1-B,5. General.

a. Size:
Panel Unit: See Figure 18, page 43.
Modulator-Power Unit: See Figure 19, page 44.

b. Weight:
Panel Unit: 5.7 pounds.
Modulator-Power Unit: 3.9 pounds.

c. Power Required:
At 13.75 Volts, 4.6 amps Receive,
7.9 amps Transmit.

At 27.50 Volts, 2.1 amps Receive,
4.9 amps Transmit.

1-C. LICENSE REQUIREMENTS.

The Federal Communications Commission requires that the operator of the transmitter in this equipment hold a Restricted Radio-Telephone Operator Permit, or higher class license. This permit may be obtained by any U.S. citizen from the nearest field office of the F.C.C.; no examination is required.

The transmitter itself, as installed in the aircraft, requires a Private Aircraft Radio Station License. This license is obtained by filing F. C. C. Form 404.

Since this equipment has been type-accepted by the FCC and entered on their list of type-accepted equipment as "***narco*** Mark 12A" it must be identified as "***narco*** Mark 12A" on your FCC Form 404 Station License Application.

CAUTION: The VHF transmitter in this equipment is guaranteed to meet Federal Communications Commission approval only when ***narco*** crystals are used.

When ordering crystals for additional channels or replacements, state ***narco*** model number to insure getting properly correlated crystals.

Use of other than ***narco*** crystals will void manufacturers warranty.

SECTION 2
INSTALLATION

2-A. INTRODUCTION.

See introduction to Section 1, page 7.

2-B. SPECIFICATIONS.

See specifications under Section 1, page 7.

2-C. UNITS and ACCESSORIES SUPPLIED.

1. ***narco*** Mark 12A Panel Unit.
   a. Domestic: 90 or 360 Communication Channels, as ordered.
   b. Export: 100 or 380 Communication Channels, as ordered.
2. Power Audio Unit.
   T12MP-12A for 14 volt operation, or
   T24MP-12A for 28 volt operation, as ordered.
3. Antenna connector, COM Transceiver.
   narco Part No. 41130-1.
4. Antenna connector, NAV. Receiver.
   narco Part No. 41237-1, Plug; with 41237-2 Ferrule.
5. Mounting base-plate, for T12MP-12A or T24MP-12A.
   narco Part No. 52085-101.
6. Set of four front panel labels ***narco*** Part No. 04271.
7. PLUG, OMNI Connector, ***narco*** Part No. 41116-1.

2-D. ACCESSORIES REQUIRED, but Not Supplied.

1. CABLE: Modulator-Power and Accessory.
   a. 8 feet long, ***narco*** Part No. 90618-96, or 90635-96.
   b. 16 feet long, ***narco*** Part No. 90618-192, or 90635-192.
2. COMMUNICATION ANTENNA: See Section 2-J,1.
3. NAVIGATION ANTENNA: ***narco*** VRP-15A, ***narco*** VRP-37, or equivalent. See Section 2-J,2.
4. COMMUNICATION ANTENNA CABLE, see Section 2-J,1
5. NAVIGATION Antenna Cable, see Section 2-J-2.
6. Headphones: Low Impedance type, 300 to 1000 ohms, or Loud Speaker, Voice coil impedance, 3 to 6 ohms nominal. Both headphones and speaker may be used if desired.
7. Microphone: Carbon, noise-cancelling carbon (low impedance), or dynamic with transistor pre-amp. The quality of transmission depends to a considerable extent on the quality of the microphone used. A noise cancelling type is very helpful and is recommended.

2-E. OPTIONAL UNITS and ACCESSORIES AVAILABLE.

2-E,1. Cables and Connectors.

a. Glide Slope Switching Cable and Connector Kit: (required if a glide slope receiver is to be controlled by the switches provided in the Mark 12A), ***narco*** Part No. EL-3077-500.

b. DME Switching Cable and Connector Kit: (required if a DME interrogator is to be controlled by the switches provided in the Mark 12A), ***narco*** Part No. EL-3077-501.

c. Connector Kit, for Modulator-Power and Accessory Cable (Required for field fabrication of the main interconnecting cable) ***narco*** Part No. EL-3077-502.

2-E,2. Omni Converters.

a. ***narco*** VOA-4. Omni Converter. For VOR or LOCALIZER Course Deviation.

b. ***narco*** VOA-5. Omni Converter, with Glide Slope Indicator. For VOR, LOCALIZER or Glide Slope Deviation.

c. ***narco*** VOA-6. Omni Converter. For VOR Course Deviation.

d. ***narco*** VOA-8 OMNI Converter. For VOR or LOCALIZER Course Deviation.

e. ***narco*** VOA-9 OMNI Converter with Glide Slope Indicator. For VOR, LOCALIZER or Glide Slope Deviation.

2-E,3. Quartz Crystals.

a. Crystal Kit, for conversion of Mark 12A Transceiver from 90 to 360 Communication Channels. ***narco*** Part No. EL-3077-503.

2-F. MECHANICAL INSTALLATION.

2-F,1. Panel Unit.

In mounting the ***narco*** Mark 12A Panel Unit the case is installed first, using mounting brackets on the sides and a grounding and supporting strap attached to the rear of the case. These supports must be fabricated by the installer. See Figure 18, page 43 for mounting dimensions.

a. Rear-Mounted Case (recommended).
Install the grounding and supporting strap from the rear stud of the case to a structural member of the airframe. Allow sufficient space behind the case for cables and access to the "airloc" fastener. Remove all paint and other finishes from the airframe, to make a good electrical ground where the supporting strap is attached.

b. Front Panel Mounting.

Where there is an existing cutout or where space limitations will not permit rear case-mounting, the case may be mounted from the front of the Instrument Panel. The cutout required to provide clearance for the mounting bracket bosses on the case will not be completely covered by the Mark 12A Trim Panel when the unit is inserted in the case.

Install a grounding and supporting strap from the rear stud of the case to a structural member of the airframe. Allow sufficient space behind the case for cables and access to the connectors.

2-F,2. Front Panel Labels.

For installation convenience and professional operational identification, a complete set of self-adhering NAV and COM labels for the Mark 12A is provided with each equipment. These labels may be used in multiple equipment installations to identify NAV-1, NAV-2, etc.

The labels should be affixed to the Front Trim Panel in the following locations:

a. For the COM Section at the upper left corner, above the panel mounting screw.

b. For the NAV Section at the upper right corner, above the panel mounting screw.

2-F,3. Modulator-Power Unit.

A Mounting Base is provided to be permanently installed in the aircraft. The Modulator-Power unit is attached to this base in a manner which permits easy removal for inspection or servicing. See Figure 19, page 44 for details .

The Mounting Base and in turn the Modulator-Power Unit must have a good electrical ground, similar to the Panel Unit. See 2-F,-1 above.

2-G. ELECTRICAL CONNECTIONS.

The ***narco*** Mark 12A Equipment consists primarily of a Panel Unit which becomes the central point for the electrical connections to the Modulator-Power Unit and to all other accessories. All connections are associated with the rear of the Panel Unit chassis. The rear of the chassis is readily accessible because the rear of the outside case is open, except for a narrow vertical strap which holds the ground-support stud and "Airloc" fastener.

All connections except the two separate antennas (Communication and Navigation) are made via two connectors attached to a short cable having two branches, extending from the rear of the Panel Unit chassis.

2-G,1. Modulator-Power and Accessory Cable.

The Panel Unit Cable branch having the large 16-circuit connector P-101 is to be connected to J-501, on the Modulator-Power (MP) Unit. Figure 21, page 45, gives the circuits between the mating connectors P-102 and P-501, corresponding with the Panel Unit connector P-101 and the MP Unit connector J-501 respectively.

The Cable Assemblies made by ***narco*** (See above D., 1.) have, in addition to the connections to the MP connector P-501, a five wire six foot cable breakout for the usual microphone, headphone and loudspeaker connections. Also extending from the opening in the P-102 Cable Connector Shell are three wires about 16 inches long for A+ input, panel lamp dimmer and auxiliary audio input.

2-G,2. OMNI/Localizer Cable.

The Panel Unit Cable branch having the small 6 circuit connector P-301 is provided for connection via a mating connector to an Omni Converter Unit such as the ***narco*** VOA-4, VOA-5, VOA-6, VOA-8, or VOA-9. Connections for such units are given in the Table below and in the information supplied with the various Omni Converter Units.

The OMNI/LOCALIZER cable should be routed as far as possible from the COM antenna and its cable. Excessive RF pickup on the OMNI/LOCALIZER cable may cause an OMNI needle deflection while transmitting. The VOA-4 and VOA-5 Navigation Converters chassis number CN63D-1 and VOA-6 chassis number CN106B-1 and later production models have rf by-pass capacitors. If rf pickup is experienced when using a Mark-12A with earlier OMNI converters, install 430 pf disc ceramic capacitors (***narco*** Part No. 21291-1) between the base and emitter of Q-103 and Q-104 in the VOA-4, VOA-5 or VOA-6 converters. These capacitors should be installed on the wiring side of the printed wiring boards, with leads as short as possible. See the converter maintenance manual for the location of these transistors.

If a ***narco*** VOA-6 Omni Converter is mounted near enough to MK 12A Equipment, it may be possible to connect the P-301 connector on the MK 12A cable directly to the compatible mating connector on the VOA-6 Equipment.

P-301 Terminal No.	Wire Color	Wire Size	Circuit Function
1	Grey	#18	Ground
2	Black	#18	+ DC Supply
3	No Conn.	—	—
4	White/Blue Tr.	#22	Omni/Loc. Relay
5	Blue	#22	Ext. Dim for VOR
6	Green	#22	Omni Signal

2-G,3. Glide Slope Channel Selector Cable.

The Navigation Receiver Channel Selector is provided with switch sections for simultaneous and automatic Glide Slope Receiver Channel Selection.

To use this switching with a Glide Slope Receiver such as the ***narco*** UGR-1A or UGR-2, it is necessary to make connections directly to certain switch sections in the Mark 12A Navigation Receiver Channel Selector Assembly. The cable is brought out of the panel unit through the round hole in the rear panel, beneath the modulator-power and accessory cable. Information on the location of the switch sections and the required connections is given in the instructions accompanying the Glide Slope Channel Selector Cable and Connector Kit. (See 2-E,1,a, above).

2-G,4. DME Channel Selector Cable.

The navigation receiver contains switches for automatic DME channel selection.

To use this switching with a DME interrogator such as the ***narco*** UDI-2AR, a cable assembly must be connected to the DME switches in the Mark 12A. The cable is brought out of the panel unit through the round hole in the rear panel, beneath the modulator-power and accessory cable. Instructions accompanying the DME Channel Selector Cable and Connector Kit show the locations of the switches and the connections, (see E,1,b, above).

2-H. PRIMARY POWER.

2-H,1. Power Source.

The primary power source may be either a nominal 14 or 28 volts, depending on the connections in the Panel Unit and whether a T12MP-12A or T24MP-12A Modulator Power Unit is used.

2-H,2. Circuit and Equipment Protection.

The primary DC circuit to the equipment should be protected with a fuse or other protective device rated as follows:

15.0 amps for a nominal 14 volt installation.
7.5 amps for a nominal 28 volt installation.

2-H,3. Voltage Conversion.

a. The Modulator Power Units are made for either a nominal 14 or 28 volt operation and are not convertible from one voltage to the other.

b. The panel unit can be used in either a 14- or 28-volt installation. A few simple wiring changes in the filament and pilot-lamp circuits constitute the voltage changeover. Figure 17, page 42, shows connections for 14 or 28 volts.

2-J. ANTENNA REQUIREMENTS.

2-J,1. Communication.

Satisfactory reception and transmission requires an antenna having a nominal impedance of 50 ohms and a low Voltage Standing Wave Radio (VSWR) over the frequency range to be used.

A simple antenna such as the ***narco*** VTP-17 bent whip may be used with a 90-channel Mark 12A. A broad-band antenna, such as the ***narco*** VP-10, is preferable with a 360-channel Mark12A. A broad-band antenna is also recommended when a 90-channel Mark 12A is installed with the intention of converting to 360 channels later.

Only one antenna is necessary for communication, since antenna changeover switching is built into the panel unit. The communication antenna should be mounted on as large and flat a metallic surface as possible. A suitable surface is often found directly in front of the windshield in fabric-covered ships, or at the center of the cabin roof in metal ships. If no such surface exists, a suitable ground plane may be provided by cementing metal foil on the inside surface of the non-metallic structure. The communication antenna should be located at least 12 inches from other objects on the surface of the aircraft.

2-J,2. Navigation.

In any VHF radio installation, the type of antenna and its location are extremely important. Only with the proper antenna in the best location can the full range and accuracy of the VHF Omni Range system be realized. In installations where an Omni converter is to be used with the ***narco*** Mark 12A navigation receiver **a horizontally polarized antenna is absolutely necessary.**

The quarter-wave whip, normally used for communications, is definitely not satisfactory, although it may appear to be when tried. While vertically polarized components of the omni signal are not normally radiated by the ground station, they are frequently produced by reflections. Therefore, a vertical antenna may receive strong signals not coming directly from the ground station, giving very unreliable bearing information.

If the Navigation Receiver in the ***narco*** Mark 12A Equipment is to be used for communication only, it may be connected to any communication type antenna which is not being used for transmission.

Either the ***narco*** VRP-15A mast-type or the ***narco*** VRP-37 fin-mounting Navigation Antenna may be used with the ***narco*** Mark 12A Navigation Receiver and an Omni Converter. A combination NAV and COM antenna such as the ***narco*** VCNA-1 or VCNA-2 is not recommended since greater frequency separation will be required between NAV and COM channels for full NAV receiver sensitivity while transmitting. See J,3 below.

The RF cable should be RG-58A/U of as short a length as is practical. All bends should have at least a 6" radius.

Two navigation receivers may be connected to one antenna if precautions are taken to provide impedance matching between receivers and antenna. The use of a ***narco*** VP-15 Antenna Diplexer will provide optimum receiver performance. An alternate method, which may result in some reduction in receiver sensitivity (depending on the input impedance of the receivers and the frequency to which each is tuned) is to connect the two receivers in parallel, using a cable 22-⅝" long

plus any multiples of 35" necessary for the installation, between the Mark 12A and the interconnecting "T". To determine the length of the cable necessary for any other ***narco*** equipment connecting to this "T", consult the appropriate Instruction Manual.

2-J,3. Important Antenna Information.

For best navigation receiver performance while transmitting, the NAV and COM antennas should be well isolated from each other. The navigation antenna should always be located well away from the engine(s) and propellor(s), and at least two feet from other antennas or wires. A wire, such as an ADF sense antenna, running near the navigation and transmitting antenna can couple transmitter energy into the NAV receiver. A good arrangement is to use a VRP-37 fin-mounting navigation antenna on the vertical stabilizer, and to mount the communication antenna as far forward as possible.

Transmitting on frequencies within about one megacycle of a desired OMNI frequency will reduce NAV receiver sensitivity. The reduction in sensitivity becomes less as the transmitter frequency is separated more from the OMNI frequency. With frequency separation greater than about one megacycle, little desensitization will be observed.

Keying or unkeying the transmitter may produce a transient in the NAV receiver and the OMNI converter. This transient would be observed as a brief jump of the OMNI indicator needle. An autopilot coupled to the OMNI converter will not respond to this transient due to the long time constant in the coupler circuits.

2-K. MICROPHONE GAIN ADJUSTMENT.

The microphone gain control, located in the Modulator /Power Unit, is factory adjusted for carbon microphones. If a microphone with substantially higher output is to be used with the Mark 12A, the gain control should be readjusted as follows:

1. Recommended Method (Bench Adjustment)
   Connect the Mark 12A and T (- -) MP-12A to a primary power source. Connect the microphone to the modulator/power and accessory cable. Connect an oscilloscope to the feed-thru capacitor located in the left front corner of the chassis (violet wire attached to this feed-thru).
   Connect a 50 ohm, 10 watt, dummy load to the COM antenna jack. If possible, have the pilot speak into the microphone in his normal manner. Turn the gain control fully counterclockwise. Key the transmitter and, while speaking into the microphone, adjust the gain control until the positive and negative voice peaks, viewed on the oscilloscope, begin flattening.
2. Alternate Method (Adjustment in Aircraft)
   Connect the microphone to the Mark 12A. Connect the common lead of a Simpson Model 260 VOM, or equivalent, to the Mark 12A chassis. Connect the probe to the feed-thru capacitor located in the left front corner of the chassis (violet wire attached to this feedthru). Set the VOM function selector to "output." Key the transmitter and while speaking a sustained "ah" into the microphone, adjust the gain control for a reading of 60 to 75 volts on the VOM.

2-L. POST-INSTALLATION CHECKOUT.

After the installation has been completed, it should be operated on the ground, with all normal power turned on and the engine(s) running. The receivers should be checked for proper operation by channelling to available signals. A ground check of the transmitter should be made to determine output and audio quality. This may be done by contacting the control tower.

CAUTION

When making tests on the COM Receiver with a Signal Generator connected to the COM Antenna Connector, do not close the microphone switch or activate the transmitter in any way. This is to protect the signal generator from transmitter output power.

SECTION 3
OPERATION

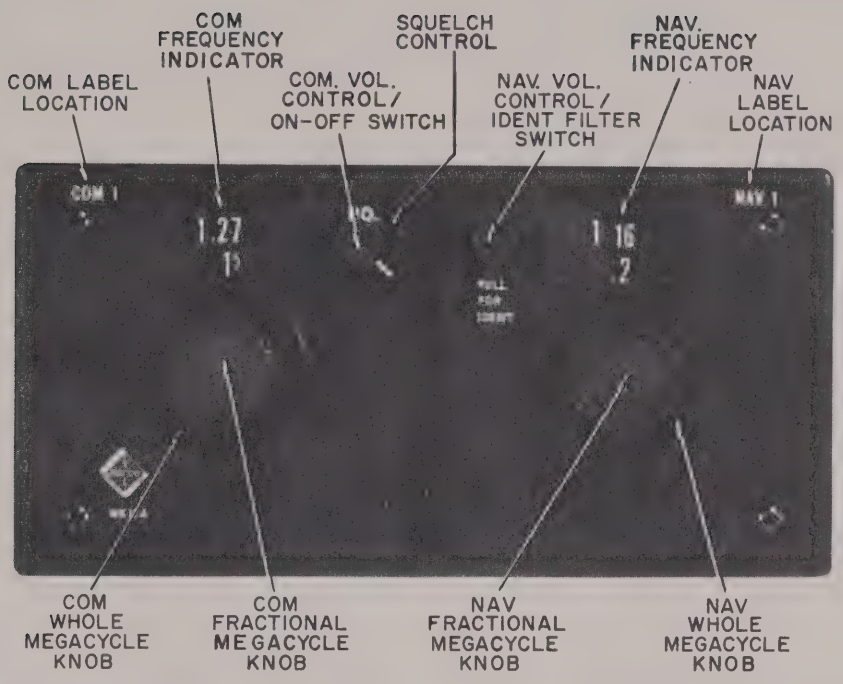


Figure 1. Controls.

3-A. INTRODUCTION.

The ON-OFF switch, part of the COM volume control, is in the primary DC line. It is OFF in the full counterclockwise position. The COM volume control affects only the COM receiver. Volume increases with clockwise rotation.

The squelch control is used to cut off COM receiver output when no signal is being received. As the control is rotated counterclockwise, stronger signals are required to override the squelch circuit action.

The NAV volume control affects only the NAV receiver. Volume increases with clockwise rotation.

Pulling the NAV volume control knob defeats the built-in ident tone filter. Code identification may then be heard. With the knob pushed in, the 1020 cps tone is removed.

The COM and NAV receivers are tuned by individual channel selectors. The knobs are turned until the desired frequency appears in the panel cutout above the channel selector.

The COM transmitter and receiver are tuned to the same frequency. Pressing the push-to-talk switch on the microphone activates the transmitter.

3-B. OPERATING PROCEDURES.

Detailed information on operation procedures is provided in the Operating Instructions booklet shipped with each unit.
Additional information on operating practices is provided in the FAA Airman's Information Manual.

SECTION 4
CIRCUIT DESCRIPTION

4-A. INTRODUCTION.

The ***narco*** Mark 12A Equipment is contained in a Panel Unit intended for aircraft instrument panel mounting and a Modulator-Power Unit which may be mounted in a remote location. The two units are interconnected by a cable which may be as much as 16 feet long.

4-A,1. Panel Unit.

The Panel Unit contains two major items, a Communication Transceiver and a Navigation Receiver. The Transceiver consists of a VHF Transmitter and Receiver, operated by a single control, to provide "simplex" communication on either 90 or 360 crystal controlled channels. The Navigation Receiver has 100 channels for OMNI Navigation and ILS Localizer service. Separate connectors are provided for Communication and Navigation Antennas.

The Panel Unit may be operated on a nominal DC Supply Voltage of either 14 or 28 volts, depending on a few simple connection changes on a terminal strip.

4-A,2. Modulator-Power Unit.

The Modulator-Power Unit contains an Audio Amplifier/Modulator and a DC to DC Converter. The Audio Amplifier serves as the transmitter modulator in the transmit condition and operates the headphones and loudspeaker in the receive condition. The DC to DC Converter changes the primary DC supply to the DC voltages required by the various circuits.

The Modulator-Power Units are not convertible from one primary DC voltage to another. There are two types available. The Type T12MP-12A is to be used on a nominal 14 volt DC supply and the Type T24MP-12A is to be used on a nominal 28 volt DC supply.

4-B. COMMUNICATION TRANSCEIVER.

4-B,1. Oscillators.

The communication transceiver consists of a VHF transmitter and receiver tuned to the same frequency by one set of frequency selector knobs. It provides simplex operation on 90 or 360 crystal-controlled channels in the domestic model, and on 100 or 380 channels in the export model.

The COM high-frequency oscillator (HFO) is a crystal-stabilized Colpitts circuit using fifth-overtone crystals in the 63 through 73 Mc/s range. The HFO transistor Q-202, is a UHF silicon transistor which provides stable operation over a wide temperature range. The collector circuit of Q-202 is tuned by C-247, C-248, C-249, C-251 and L-218 with a step inductor, L-219, which adjusts the tank to resonance at each frequency. Feedback is applied to the oscillator emitter through the crystal, which operates in its series-resonant mode. The choke across the crystal, L-221, is parallel-resonant with the crystal holder capacitance in the oscillator frequency range. It prevents free-running oscillation should a crystal fail.

HFO output is coupled through C-266 to the base of Q-201, the HFO doubler. Q-201 is biased near cutoff, and its collector tank is tracked to tune at twice the oscillator frequency. It therefore doubles the HFO frequency. The doubler output frequencies range from 126 to 145 Mc/s. Table I gives the oscillator and doubler frequencies for each whole megacycle position.

The COM low-frequency oscillator (LFO) is a crystal-controlled Colpitts oscillator operating in the 8.5 to 9.5 Mc/s range. For any communication channel, the LFO frequency for transmitting is always removed .500 Mc/s from the frequency for receiving. Table II gives the transmit and receive crystal frequencies for each fractional megacycle channel.

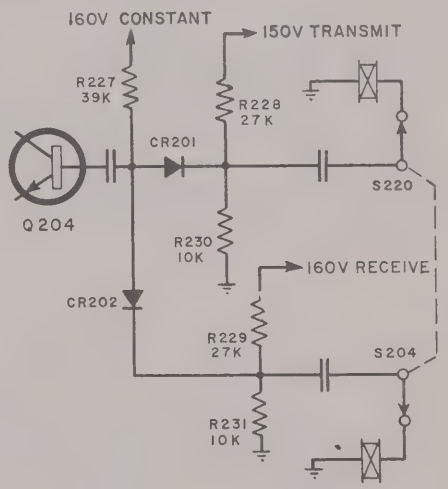


Figure 2.
COM LFO DIODE SWITCHING.

Switches S-204 and S-220 are attached to one rotor, and always select two crystals separated by .500 Mc/s. Diodes CR-201 and CR-202 select the proper crystal for transmitter or receiver operation. The anodes of both diodes are biased at about +30 volts through R-227, which is attached to the +160 v. constant line. During transmission periods, the cathode of CR-201 is raised to about +50 volts by voltage divider R-228 and R-230, from the +150 v. transmit line to ground. CR-201 is therefore reverse biased. CR-202, however, conducts through R-231 and presents a low-impedance path from the transistor base to S-204. In the receive mode the situation is reversed. CR-202 is reverse biased by voltage from the +160 v. receive line, while CR-201 conducts and connects S-220 to the transistor. LFO output is taken from the emitter of Q-204.

4-B,2. Communication Transmitter.

The desired transmitter frequency is generated by V-204, a 6AR8 beam-deflection balanced mixer. C-238 couples energy from the HFO doubler to the control grid of the mixer. Q-203 amplifies LFO energy. T-201, a broad-band tuned transformer, steps the amplified LFO signal up to the voltage needed to drive the mixer deflection plates.

The plate load for the mixer is a balanced circuit tuned to the transmitting frequency. Much of the tuning capacitance is in the two pieces of shielded cable connecting the mixer plates to L-214 and step inductor L-212. This balanced circuit suppresses doubled HFO energy, which is applied to the mixer unbalanced. LFO energy, although applied to the mixer in a balanced fashion is, far enough removed from the transmitting frequency to be adequately attenuated by the transmitter tuned circuits.

The transmitter consists of three amplifiers, V-201, V-202 and V-203. They are coupled to each other and to the antenna by tracked pi-networks. A low-pass filter, consisting of L-101, L-102, C-101, C-102 and C-103, attenuates harmonics of the transmitting frequency. L-116 and C-170 form a series-resonant trap to further attenuate LFO energy.

4-B,3. Communication Receiver.

The communication receiver is a double-conversion superheterodyne receiver using a tracked high-frequency IF and a fixed low-frequency IF. The signal from the antenna is fed to the RF amplifier, V-101, through the transmit-receive switch, CR-101.

In the receive mode, CR-101 is forward biased by voltage from the +160 v. transmit line, applied through R-101. The diode then presents a low impedance to RF signals. When transmitting, the +160 v. receive voltage is removed, and negative voltage from the control grid of the transmitter final amplifier, V-201, is applied to the diode through R-204 and R-101 to reverse bias the diode. In this "off" state, the diode prevents transmitter energy from blocking or damaging the receiver.

The VHF signal is amplified by V-101 and coupled by a tuned circuit to the first mixer, V-102. Doubled HFO energy is also applied to this tube through C-120. The doubled HFO frequency is 8.5 to 9.5 Mc/s higher than the received signal frequency. The two signals mix in V-102 to produce an intermediate frequency in the 8.5 to 9.5 Mc/s range.

The intermediate-frequency signal is coupled to the second mixer by three coupled tuned circuits. The first two branches are inductively coupled by T-101, and the second and third branches are bottom-capacitance coupled by C-130. Since the doubled HFO frequency is constant for all twenty fractional megacycle channels associated with any whole megacycle channel, there are twenty possible intermediate frequencies. The high-frequency IF circuits are tuned to these twenty frequencies by step inductors L-109, L-110 and L-111, which are driven by the fractional megacycle selector knob.

The high-frequency IF signal is applied, along with the COM LFO signal, to the control grid of the second mixer, V-103-A. The LFO frequency is always .500

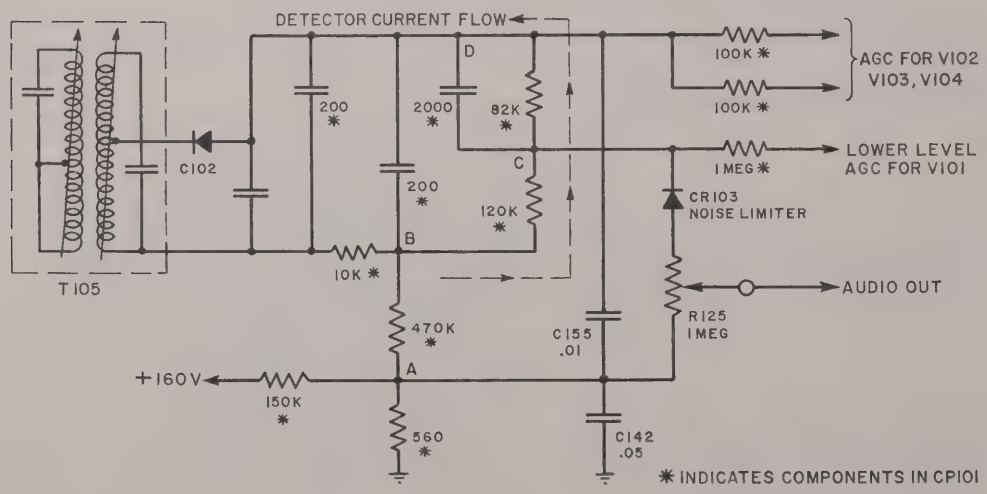


Figure 3. COM Detector Schematic

Mc/s removed from the high-frequency IF frequency. For the .00 through .45 fractional megacycle positions, the LFO frequency is .500 Mc/s lower than the high-frequency intermediate frequency. For the .50 through .95 positions the LFO frequency is .500 Mc/s higher than the high-frequency intermediate frequency.

The two signals mix in V-103-A to produce a .500 MC/s low-frequency intermediate frequency. This signal is amplified by V-104 and Q-101, then detected by CR-102.

The voltage divider formed by the 150K ohms and 560 ohms resistors in CP-101 holds point A at approximately 0.5 volt above ground. As long as no current flows through the 470K resistor, point B is at the same potential as point A. Detector current flow through the 120K and 82K resistors causes points C and D to be more negative than points A and B. These potentials are used as AGC. AGC from point C is at a lower level than that at point D. That from point C is applied to V-101 which, being a sharp cut off pentode, would be cut off by the higher potential at point D.

The voltage developed across the 120K resistor by detector current flow forward biases CR-103, the COMM noise limiter. CR-103 then presents a low impedance to audio signals, which appear across volume control R-125. The 2000 pf capacitor is a relatively high impedance at audio frequencies. The high frequencies of a noise pulse, however, see the 2000 pf capacitor and C-155 as a low impedance. The voltage across these two capacitors cannot change rapidly enough to follow a noise pulse, so the forward bias on CR-103 is reduced for the duration of the pulse. The diode then presents a high impedance to audio signals, reducing the level of noise signals.

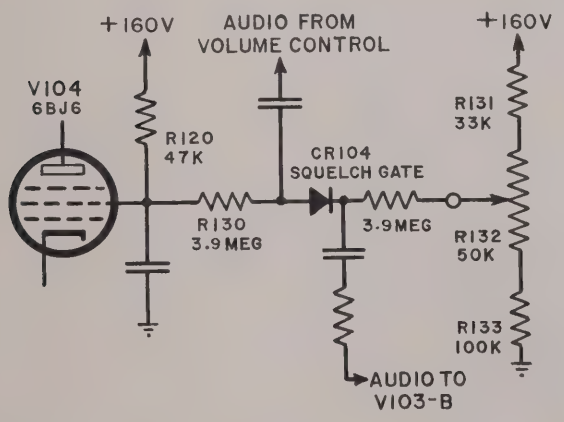


Figure 4. Squelch Gate Schematic

CR-104 is the squelch gate. The anode of this diode is biased by the screen-grid potential of V-104, applied through R-130. The screen potential varies with AGC variations. It is lowest under no-signal conditions, when tube current is high. The cathode potential of CR-104 is set by R-132, the squelch control. If the cathode potential is greater thaen the screen voltage the diode is reverse biased, and the audio signal is blocked. R-132 is set to reverse bias CR-104 under no-signal conditions. When a signal is received, AGC voltage is developed. The screen voltage increases and the diode is forward biased, so it passes the audio signal.

4-C. NAVIGATION RECEIVER.

The Navigation Receiver is a dual-conversion superheterodyne receiver employing a tracked high frequency IF and a fixed low frequency IF. The VHF signal from the antenna is coupled by L-301 and C-301 to the RF amplifier, V-301. It is amplified and coupled by a double tuned circuit to the first mixer, V-302, where it is mixed with the high frequency oscillator output.

The high frequency oscillator is a crystal stabilized, modified Colpitts circuit. Feedback to sustain oscillation is applied through fifth overtone type crystals. The frequency of oscillation is therefore stabilized at the series resonant frequency of the crystal. The A+ voltage for the oscillator transistor, Q-301, is stabilized by a zener diode for frequency stability.

The high frequency oscillator operates in the 96 through 106 Mc/s range. Its frequency is set by the NAV whole megacycle selector. Table III gives the oscillator frequency for each channel.

The plate circuit of V-302 is tuned to the difference between the incoming VHF and the high frequency oscillator frequencies. This high frequency intermediate frequency is different for each setting of the fractional megacycle selector. The high frequency IF transformer, T-301, is tuned for each different frequency by L-307 and L-308. These step inductors are controlled by the fractional megacycle selector.

The high frequency IF signal is mixed with the low frequency oscillator signal in the second mixer, V-303. The low frequency oscillator, V-304, is a Colpitts circuit operating in the 10.3 to 11.3 Mc/s range. It is inductively tuned by step inductor L-315, which is operated by the NAV fractional megacycle selector. The LFO frequency is always 1.125 Mc/s lower than the high frequency IF. Table IV gives the oscillator frequency for each channel.

The difference frequency between the HF IF and the LFO frequency, 1.125 Mc/s, is selected by T-302 and amplified by Q-302 and Q-303. T-302 is overcoupled to provide the necessary bandwidth.

The second IF amplifier (Q-303) output is coupled through T-303 to the detector circuit. The operation of this output transformer is unusual; therefore, a simplified equivalent operational circuit is given in Figure 6 and explained in detail below. Transformer T-303 is tuned as follows: (a) Primary is paralled resonant, and (b) secondary is series resonant with C-334, providing the voltage step-up required for proper OMNI and localizer operation. The primary is adjusted for parallel resonance, which presents a high impedance to the Q-303 collector circuit. The secondary is adjusted for series resonance, which serves to step-up the signal voltage to the detector. The tune-up procedure differs from that for alignment of other IF transformers. Refer to paragraph 5-G,1, Page 29 for alignment instructions.

As shown in Figure 5, detector current flowing through CR-303, the secondary of T-303, and the 150K and 180K resistors forward biases CR-303. C-336 prevents the potential at the cathode of CR-303 from changing very rapidly, although it can follow audio frequencies to slightly over 2000 CPS. The cathode cannot follow a fast noise pulse. Noise pulses, therefore, drive the cathode of CR-303 negative with respect to the cathode. The diode is then biased off and presents a high impedance to audio signals for the duration of the noise pulse.

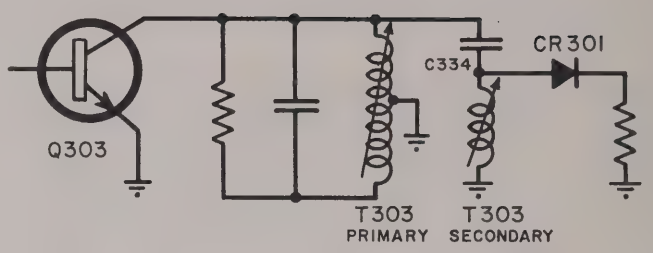


Figure 6.
IF Transformer T-303, Equiv. coupling circuit

CR-302 sets the AGC threshold. Under low-signal conditions, CR-302 is forward biased by potential from the +160V constant line through R-315. The AGC line is therefore slightly above ground potential. As the signal level increases, the negative voltage at the detector load reverse-biases CR-302, and the negative AGC voltage is applied to the tubes.

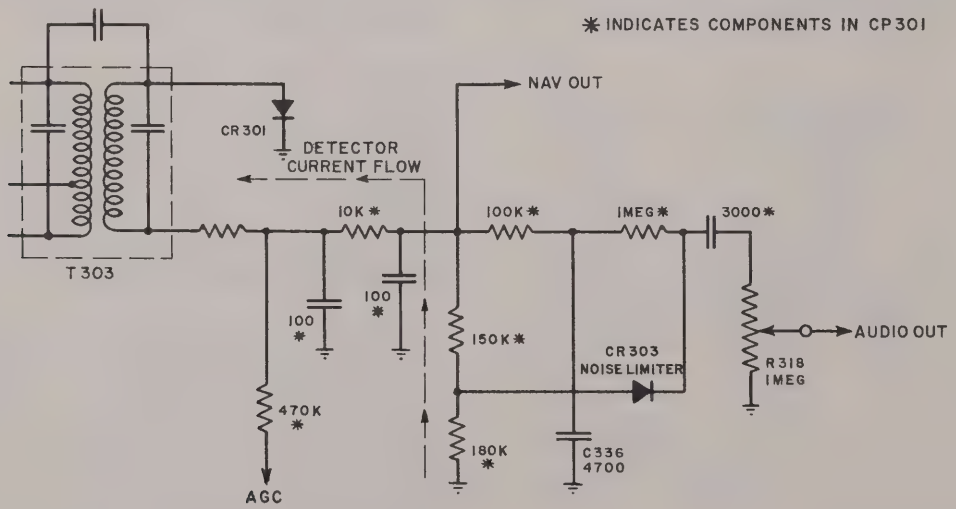


Figure 5. NAV Detector Schematic

4-D. MODULATOR-POWER UNIT.

4-D,1. Power Circuits.

The power supply section of the T( ) MP-12A uses two power transistors, Q-501 and Q-502, and a power transformer, T-501, in a circuit whose simplified operation is as follows. The instant primary voltage is applied (A+), because of the inevitable dissimilarity of the two transistors more current will flow in one than in the other. This greater flow of current through one half of the primary winding of the power transformer induces a bias on the transistors such that the conducting unit is driven into greater conduction and the other is held at cut-off.

Almost instantly the transformer reaches saturation. Thus having reached maximum flux density, there is no more induced voltage in the bias windings which are connected to the transistor circuitry. Therefore, the current through the conducting transistor decreases, and bias voltage at opposite polarity is developed which cuts off this transistor and simultaneously causes the second transistor to conduct. The above procedure repeats with the second transistor. This switching action repeats at high speed and the resultant output voltage of T-501 is essentially a square wave.

A full wave bridge rectifier consisting of CR-501, CR-502, CR-503, and CR-504 in conjunction with the center tapped secondary of T-501 provides a simple means of obtaining a dual voltage output. Filtering of these DC voltages is easily accomplished because of the high frequency of the power supply.

4-D,2. Audio Circuits.

Audio signals from the two volume controls are combined in CP-302, then applied to the grid of the first audio amplifier, V-103-B. The amplified audio signal at the plate of V-103-B is applied to the base of Q-304 through a parallel tuned filter consisting of C-340 and L-317. This filter is tuned to 1020 cps. It presents a high impedance at this frequency to provide approximately 20 db rejection of the code identification tone transmitted by navigation stations. S-313, the push-pull switch attached to the NAV volume control, shorts out the filter when pulled. This permits the pilot to hear the code identification. When the knob is pushed in the tone is reduced to make voice transmissions more understandable. Q-304 is an emitter follower providing an impedance match to the audio power amplifier.

The remainder of the audio circuit is located in the modulator/power unit. In the receive mode, the audio signal from Q-304 is switched by K-501 to the base of Q-401, the audio driver. The audio output is switched by K-501 to the speaker output lead, and is applied at all times to the headphone lead.

In the transmit mode, audio signal from the microphone is switched by K-501 to the base of Q-401. Audio output is taken from the modulation winding of T-402. In this case, K-501 switches B+ to the modulation winding to activate the transmitter.

SECTION 5
MAINTENANCE
SERVICE PROCEDURE

5-A. INTRODUCTION.

The ***narco*** Mark 12A Equipment consists primarily of an aircraft instrument Panel Unit, having direct manual controls and a remote mounted modulator-power unit. All interconnections are normally made at or near the rear of the Panel Unit. There are separate single circuit connectors for the Communication and Navigation Antennas on the rear panel.

From the maintenance standpoint, the Mark-12A is similar to the Mark-12. The following differences should be noted however:

- All oscillators except the NAV LFO are transistorized and are powered by a zener diode-regulated source.
- The output IF amplifier in each receiver is transistorized.
- To couple adequate power from the NAV receiver to a navigation converter, a special IF alignment procedure is employed.
- The navigation receiver operates at all times, including transmitting periods.
- An ident filter is added in the audio circuit.
- The frequency-selector knobs are redesigned.
- Layouts of both the panel unit and the power supply have been revised for easier servicing.
- A microphone gain control is added to the power supply.

5-A,1. Panel Unit Connections.

The Panel Unit has a short cable with two branches extending from the rear. The smaller branch has a 6 circuit connector which may connect directly or via an extension cable to a ***narco*** VOA-6 OMNI Converter, or via an adaptor cable to a ***narco*** VOA-4, VOA-5, VOA-8, VOA-9 or other Navigation Converter. The larger branch has a 16 circuit connector to accommodate the connector and cable for the Modulator-Power Unit and the connections to the primary DC power and accessories.

If a glide slope receiver or DME interrogator is controlled by the NAV receiver channel selectors, there will be one or two additional cables extending from the rear of the panel unit.

For details of these interconnections see Figures 23 and 24.

5-A,2. Replacement Parts.

A complete list of replacement parts is on pages 57 through 67. The following table lists the parts most often needing replacement. In some cases, realignment may be necessary after replacing a part. V-204 is specially constructed for electrical balance. It should, if possible, be replaced with one obtained from ***narco***. Most of the transistors and diodes are manufactured to ***narco*** specifications. The commercial replacements listed are not exact equivalents, and should be used only if absolutely necessary.

Item	Total Quantity	*narco* Part No.	Commercial Replacement
DIODES			
CR-101			
CR-102, CR-301	1	75013-5	1N486B
CR-103, CR-104,	2	75019-2	CD6487
CR-201, CR-202,			
CR-302, CR-303	6	75013-4	1N486B
CR-105			
CR-501, CR-502,	1	75025-2	8.2V, 1 Watt Zener
CR-503, CR-504,			500 PIV, 750 ma
	4	75204-45	Silicon Diode
CR-505, CR-506	2 (28V		500 PIV, 750 ma
	Unit only)	75204-45	Silicon Diode
FUSES			
F-501	1 (14V		
F-501	Unit only)	66504-12	10A, SLO-BLO
	1 (28V		
	Unit only	66504-10	6-¼A, SLO BLO
LAMPS			
I-101, I-102	2	#53 RED	#53 RED
TRANSISTORS			
Q-101, Q-201,			
Q-202, Q-301,	5	75547-2	2N3478 (see above)

Item	Total Quantity	*narco* Part No.	Commercial Replacement
TRANSISTORS (Continued)			
Q-303			
Q-203, Q-204,			
Q-302, Q-304	4	75550-7	2N3391
Q-401	1	75534-4	2N376A (hfe = 120 to 160)
Q-402, Q-403	2 (14V		
	Unit only)	75534-3	2N376A (hfe = 100 to 130)
Q-402, Q-403	2 (28V		
	Unit only)	75511-3	2N1136B
Q-501, Q-502	2 (14V		
	Unit only	75548-3	2N441
Q-501, Q-502	2 (28V		
	Unit only)	75505-3	2N174
TUBES			
V-101	1	6BH6	6BH6
V-102	1	6AK5	6AK5
V-103	1	6EA8	6EA8
V-104,			
V-301	2	6BJ6	6BJ6
V-201	1	7551	7551
V-202,			
V-203	2	8106	8106
V-204	1	75401-1	6AR8 (see above)
V-302,			
V-303	2	6CB6	6CB6
V-304	1	6CW4	6CW4

5-B. MECHANICAL MAINTENANCE.

5-B,1. Panel Unit Access.

The Panel Unit Case is normally installed permanently in the aircraft. To remove the unit, it is only necessary to disconnect the cables at the rear of the chassis and release a single "Airloc" fastener. The unit may then be withdrawn from the front of the case.

The open frame chassis design is such that practically every component, except the ones in the three small shielding compartments, is readily accessible as soon as the unit is withdrawn from the case. Disassembly and re-assembly of the COM and NAV Channel Selectors is somewhat involved, but detailed instructions for the procedure are given in paragraphs B,4 through B,11 below.

The components in the three small shielding compartments are made accessible by removing the covers, which are held in place by small screws. The two compartments near the center of the chassis have both top and bottom covers.

A certain sequence of replacing the covers of the center compartments is helpful. The bottom cover on the left center (COM side) may be removed and replaced without disturbing the top cover. However, if the top cover is removed, it will be easier to remove the bottom cover before reassembly of the top cover. Once the top cover is in place, the bottom cover may be reassembled without difficulty.

NOTE: The bottom cover fits *inside* the top cover.

The top cover on the right center compartment (NAV Side) may be removed and replaced without disturbing the bottom cover. However, if the bottom cover is removed, it will be easier to first remove the top cover before reassembly of the bottom cover.

The remaining compartment at the bottom left front (COM side) has only one cover. It is held in place by one screw at the rear flange of the cover and two tabs on the front flange of the cover. The tabs fit into slots at the front of the compartment proper.

5-B,2. Modulator-Power Unit Access.

The Modulator Power Unit is usually installed in a remote location on a Mounting Base. The Mounting Base is normally installed permanently. To remove the Unit, it is only necessary to loosen (without removing) four mounting crews and detach the single cable connector. Access to all components is then made by removing the screws holding the two "L" shaped pieces covering the four sides.

If the Transistor Q-401 (First Audio Amp.) is removed, care must be exercised to prevent damaging the insulator under the mounting, and to replace it properly.

5-B,3. Periodic Service.

The only item which may require occasional attention is the COM Fractional Mc Channel Selector Detent Assembly, near the rear of the chassis. It consists of a star wheel, roller, and detent fulcrum, which should be lubricated with wide temperature range grease. It is recommended that this assembly be checked whenever the Unit is removed for electrical maintenance.

5-B,4. Channel Selector Knob, Dial and Shaft Removal, Replacement and Positioning.

The procedures for disassembly and re-assembly of the Channel selectors given in the succeeding paragraphs B,5., through B,9., give a procedure which should maintain the proper relations among the Knobs, Dials, Shafts, and Switch Section Rotors and Stators. If these relations become mis-arranged for any reason the correct relations may be re-established according to the sub-section B,10., below.

NOTE: In the succeeding sub-sections through B,11., all references to mechanical position such as top and bottom, left and right, front and rear as viewed facing the front of the Panel Unit in an upright position.

5-B,5. COM Fractional Mc Shaft, Removal and Replacement.

Removal Procedure:

a. Remove detent spring and roller which engages the star wheel assembly at the left side rear of the set on the COM, Fractional Mc Shaft and then loosen the two set screws in the star wheel assembly.

b. Rotate the COM Mc Knob to the 118 position, the COM Fractional Mc Dial to the 0.3 position, and the NAV Mc Knob to the 108 position and the NAV Fractional Mc Dial to the 0.6 position.

CAUTION: If the knobs and dials are not set as indicated, the switch sections may be damaged, when the shafts are removed as described under step g. below.

c. Loosen set screws and remove from the unit both volume knobs, squelch knob, and both whole megacycle knobs.

d. Loosen and remove the four screws at the corners of the trim panel. The panel can now be removed by pulling it forward from the unit.

e. Loosen set screws in both fractional megacycle knobs and in both whole megacycle dials. Set screws in the dials are accessible when the fractional megacycle knobs are rotated to line up access holes.

f. Front of chassis is now exposed. On the left hand side is the COM Mc detent. Remove its screws, nuts, lockwashers, and the spacers which retain the detent assembly to the front of the chassis.

g. Note that it is necessary to remove the COM Mc Shaft in order to remove the COM Fractional Mc Shaft. Both COM Mc Shaft and detent assembly and COM Fractional Mc Shaft can now be withdrawn simultaneously from the front of the chassis.

Replacement Procedure: Follow the Removal Procedure in reverse.

5-B,6. COM Whole Mc Shaft and Detent Assembly, Removal and Replacement.

Removal Procedure:

Follow instructions described in Removal Procedure B,5., above but omit step a. and step g. The COM Mc Shaft and Detent Assembly can now be withdrawn from the front of the chassis without disturbing the COM Fractional Mc Shaft and Detent.

Replacement Procedure:

Follow the Removal Procedure in reverse.

5-B,7. NAV Whole Mc Shaft and Detent Assembly, Removal and Replacement.

Removal Procedure:

a. See Removal Procedure B,5., above and perform steps b., c., d., and e.

b. After the above steps have been completed, the front of the chassis will be exposed and on the right hand side will be the NAV Mc Shaft and Detent Assembly. This can then be removed by loosening and removing the two mounting nuts and lockwashers at the rear of the variable inductor and crystal switch section assembly.

c. In the same area remove the hairpin retainer from the NAV Mc Shaft.

d. On the front of the chassis the two long strut screws can now be removed, but be careful to note the location of the two metal spacers in the wafer assembly.

e. The NAV Mc Detent and Shaft Assembly can now be withdrawn from the front of the chassis.

Replacement Procedure:

Follow the Removal Procedure in reverse.

5-B,8. NAV Fractional Mc Shaft, Removal and Replacement.

Removal Procedure:

a. Position the NAV Fractional Mc Dial to 0.6. Then loosen the set screw which is seated the deepest in the NAV Fractional Mc Knob and remove the knob and its bushing from the Unit.

b. Loosen the two set screws in the hub of the NAV Fractional Mc Dial.

c. At the rear of the L.F. Oscillator, glide slope, and variable inductor switch sections, there is a detent rotor assembly. Loosen the two set screws in the detent rotor assembly and also remove the hairpin retainer on the NAV Mc Shaft in front of the L.F. Oscillator Assembly.

d. Then from the front of the chassis, push in the NAV Fractional Mc Shaft flush with the front of the NAV Whole Mc Shaft. It will be seen by this operation that the NAV Fractional Mc Shaft will be protruding to the rear of the set, at the rear of the LF oscillator and switch section assembly. Continue to withdraw the shaft to the rear of the set.

e. In the rear panel there is a clearance hole provided to facilitate the removal of this shaft. Any wires interfering with this clearance hole should temporarily be carefully dressed aside.

Replacement Procedure:

Follow the Removal Procedure in reverse.

5-B,9. Reference Positions for Channel Selector Dials, Shafts, and Switch Sections.

a. COM Fractional Megacycles.
For the 0.5 Fractional Mc position the ⅜" diameter metal shaft flats will be in a horizontal plane, with the key notch in the Switch Section Rotors at the top.

All of the Switch Section Stators have the letter "X" stamped on the front right side adjacent to the strut screw.

b. COM Whole Megacycles.

For the 118 Whole Mc Position the ⅜" diameter glass epoxy shaft flats will be 18° clockwise from a vertical plane, with all the key notches in the Switch Section Rotors on the right side at 108° clockwise from the vertical.

The first seven Switch Section Stators have the upper right hand corner cut off. The remaining four, have the letter "X" stamped on the top front of the section.

c. NAV Whole Megacycles.

For the 108 Whole Mc position the flats on the ¼" diameter *brass* shaft will be in the same plane as the mounting strut screws in the Crystal Switch Assembly. The key notch in the eight Switch Section Rotors is on the flat toward the bottom of the Unit.

The eight Switch Section Stators have a raised key moulded on the peripheral surface, which appears at the right of the top strut screw.

d. NAV Fractional Megacycles.

For the 0.6 Fractional Mc dial position the flats on the ¼" diameter *steel* shaft shall be in the same plane as the mounting strut screws in the L.F. Oscillator Assembly. The key notch of the rotor in the enclosed shielded switch section (top cover removed) is on the flat toward the top of the Unit. The key notches in the four switch section rotors behind the enclosed shielded switch section, are on the flat toward the bottom of the Unit.

The switch section stator in the shielding compartment has a large cutout at the top. The remaining five stators have a raised key moulded on the peripheral surface, which appears at the right side below the upper strut screw.

5-B,10. COM Detent Spring Position, Fractional Mc, Ch. Sel. Switch.

When the detent star wheel assembly is installed for 10 position operation, the long end of the detent spring shall be located on the inside edge of the tab nearest the shaft.

When the detent star wheel assembly is installed for 20 position operation, the long end of the detent spring shall be located on the inside edge of the outermost tab from the shaft.

5-B,11. NAV Detent Position, Fractional Mc, Ch. Sel. Switch.

This detent position is not related to any particular fractional Mc position, but it must be seated when the rotor blade is centered on any stator contact. This centering may be observed on the switch section in the enclosed shielded compartment, when the top cover is removed.

5-C. ELECTRICAL MAINTENANCE.

5-C,1. Precautions.

a. Supply Voltage.

All specifications in the following sections should be met with a DC input voltage of 13.75 or 27.5 volts, depending on the requirements of the unit being aligned. Unless a well-regulated primary power supply is used, the input voltage must be adjusted to the correct value when the transmitter is keyed.

b. Duty Cycle.
Observe a 50% duty cycle when aligning the transmitter (one minute on and one minute off).

5-C,2. Equipment Required.

a. RF Power Wattmeter — Bird Termaline or equivalent.

b. VTVM — RCA Voltohmyst or equivalent, with RF probe.

c. AC VTVM — Ballentine Model 300D or equivalent.

d. Carbon Microphone.

e. Signal Generator — General Radio Model 1001A or equivalent.

f. Signal Generator — Hewlett-Packard Model 608D or equivalent.

g. Audio Wattmeter — General Radio Type 583-A or equivalent.

h. High Impedance Detector—See Figure 13, Page 41.

i. Frequency Counter — Hewlett-Packard Model 524B or equivalent, or — BC-221-D or equivalent.

5-C,3. Alignment, 90 vs 360 Channels.

The following alignment instructions are written for the 360 channel COM transceiver. For a 90 channel unit, when instructions call for 135 Mc/s use 126 Mc/s, and when .95 is specified use .9.

5-D. COM OSCILLATORS.

5-D,1. COM High Frequency Oscillator.

a. Connect a RF VTVM probe to the base of Q-201, the HFO doubler. Refer to Photo J, page 55.

b. Set the COM megacycle selector to 118. Adjust C-251 for maximum RF indication.

c. Set the megacycle selector to 135. Adjust L-218 for maximum RF indication.

d. Repeat steps b., and c., until no further increase in RF indication can be obtained.

e. Check to insure oscillator is operating in each megacycle position. Operation is indicated by a normal RF voltage reading.

Normal indication: 0.5 to 0.7 V RMS.

5-D,2. COM Low Frequency Oscillator.

a. Connect a RF VTVM probe to the emitter of Q-204, the low frequency oscillator.

b. Check to insure oscillator is operating in each fractional megacycle position. Operation is indicated by a normal RF voltage indication.

Normal indication: 2.0 to 2.5 Volts RMS.

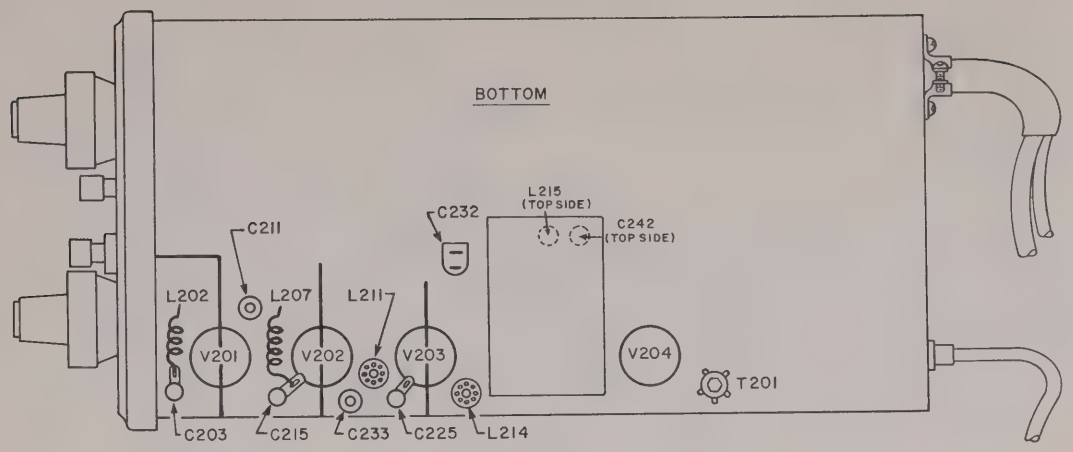


Figure 7.
COM Transmitter, Test Connections.

5-E. COM TRANSMITTER.

5-E,1. Balanced Mixer and Buffer Alignment.

a. Connect a RF wattmeter to J-101, the COM antenna connector.

b. Connect DC VTVM probe to C-223.

c. Set the channel selector dials to 118.50 Mc/s. Key the transmitter and adjust T-201 for maximum negative voltage indication.

d. Key the transmitter and adjust C-242, C-232 and C-225 for maximum negative voltage indication.

e. Set the channel selectors to 135.50 Mc/s. Key the transmitter and adjust L-215, L-214 and L-211 for maximum negative voltage indication.

f. Repeat steps d., and e., until no further increase in negative voltage can be obtained.

g. Set the COM Mc. selector to 135 and readjust T-201 for approximately equal negative voltage indications at the .00 and .95 fractional megacycle positions.

Normal Indication: -2 to -10 Volts DC.

5-E,2. Final Drive Adjustment.

a. Connect the DC VTVM probe to C-211.

b. Set the channel selectors to 118.50 Mc/s. Key the transmitter and adjust C-215 for maximum negative voltage indication.

c. Set the channel selector dials to 135.50 Mc/s. Key the transmitter and adjust L-207 for maximum negative voltage.

d. Repeat steps b., and c., until no further increase in negative voltage can be obtained.

e. Slide the panel unit into its dust jacket. Set the Mc. channel selector to 118. Key the transmitter and adjust C-215 for approximately equal negative voltage indications at the .00 and .95 fractional megacycle positions.

f. Set the Mc. channel selector to 135. Key the transmitter and adjust L-207 for approximately equal negative voltage indications at the .00 and .95 Mc. positions.

g. Repeat steps e., and f., until negative voltage indications at the .00 and .95 Mc. positions are approximately equal at 118 Mc/s or 135 Mc/s. Note that the voltage indication at 118 will generally be different from that at 135. Do not attempt to balance readings at 118 and 135 Mc/s.

Normal Indication: –30 to –60 Volts DC.

5-E,3. Final Amplifier Alignment.

a. Set the channel selectors to 118.50 Mc/s. Key the transmitter and adjust C-203 for maximum RF output power as indicated on the RF wattmeter.

b. Set the channel selectors to 135.50 Mc/s. Key the transmitter and adjust L-202 for maximum RF power output.

c. Repeat steps a., and b., until no further increase in power output can be obtained.

d. Slide the panel unit into its dust jacket. Set the megacycle channel selector to 118. Key the transmitter and adjust C-203 for approximately equal power indications at the .00 and .95 positions.

e. Set the megacycle channel selector to 135. Key the transmitter and adjust L-202 for approximately equal power indications at the .00 and .95 positions.

f. Repeat steps d., and e., until power indications at the .00 and .95 positions are approximately equal at the 118 or 135 position. Note that the power indication at the 118 position will generally be different from that at 135. Do not attempt to balance readings at the 118 and 135 positions.

Normal Indication: Lower frequency 50% of total channels — 9.0 watts minimum.

Higher frequency 50% of total channels — 7.0 watts minimum.

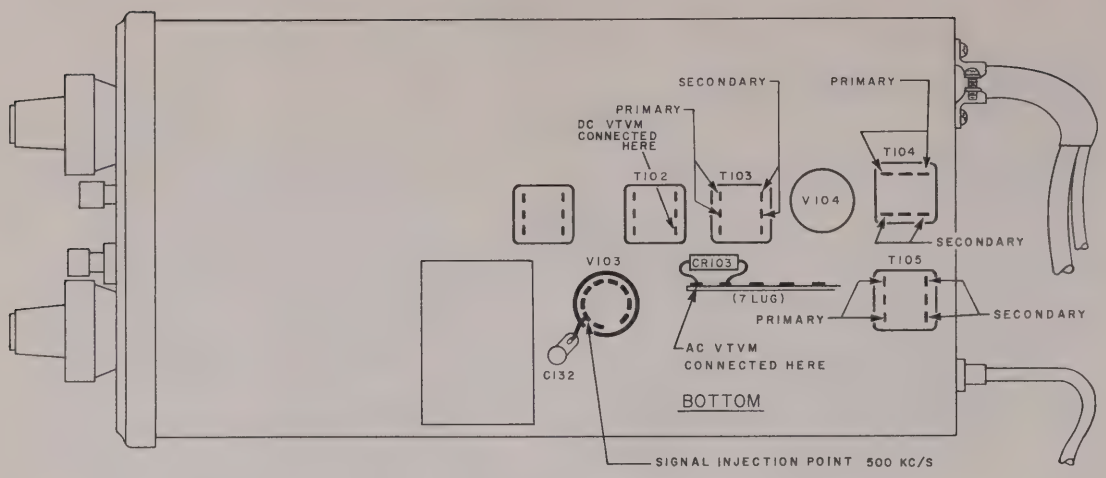


Figure 8.
COM RECEIVER TEST CONNECTIONS
LF IF ALIGNMENT and BANDWIDTH CHECK.

5-F. COM RECEIVER.

5-F,1. Low Frequency IF Amplifier.

a. Connect an AC VTVM to the anode (unbanded end) of CR-103.

b. Connect a DC VTVM to C-117.

c. Remove all connections from Pin 2, V-103. Connect a 47 ohm resistor from Pin 2, V-103 to ground.

Connect a signal generator to Pin 2, V-103. Set the signal generator to 500 Kc/s. Set the signal generator output level to the lowest value which will give a useable negative voltage indication on the DC VTVM (with no signal, the DC VTVM should indicate a positive voltage).

d. Temporarily connect a 33K resistor across the secondary winding of each LF IF transformer, T-103, T-104 and T-105. Keep resistor leads short to avoid regeneration.

e. Adjust the primaries (tuning slugs nearer the chassis) of T-103, T-104 and T-105 for maximum negative voltage indication on the DC VTVM. Reduce the signal generator output as necessary to maintain a minimum useable negative voltage indication.

f. Remove the 33K resistors from the secondary windings, and temporarily attach them to the primary windings of T-103, T-104 and T-105.

g. Adjust the Secondaries (tuning slugs farther from the chassis) of T-103, T-104 and T-105 for maximum negative voltage indication on the DC VTVM. Reduce the signal generator output as necessary to maintain the minimum useable negative voltage indication.

h. Remove the three 33K resistors. Modulate the signal generator 30% with a 400 cps signal. Adjust the signal generator output level to produce a reading of 0.4 Volt RMS on the AC VTVM.

Normal Indication: 75 μv maximum input for 0.4 V A.C.

i. Remove all test equipment and replace all connections to Pin 2, V-103.

5-F,2. LF IF Bandwidth

a. Connect a DC VTVM and signal generator as described in steps b., and c., under F,1., above.

b. Adjust the signal generator output level to produce a useable negative voltage indication on the DC VTVM. Vary the signal generator frequency over the IF passband. The negative voltatge indication should peak approximately 10 Kc/s either side of 500 Kc/s, with 500 Kc/s falling at the bottom of the dip between peaks. Use the DC VTVM reading at this dip as the reference level for bandwith measurement.

c. Increase the signal generator output 6 db (2:1) above the value used in step b. Tune the signal generator frequency above 500 Kc/s until the reference level is obtained on the DC VTVM and note the frequency. Tune the generator below 500 Kc/s until the reference level is again reached and note that frequency. The difference between these two frequencies is the total of 6 db bandwith.

d. Increase the signal generator output level 60 db (1000:1) above the value used in step b., above. Tune the signal generator frequency above and below 500 Kc/s until the reference level is reached, as in step c., above. The difference between these two frequencies is the total 60 db bandwidth.

Normal Indication: 6 db — 30 Kc minimum total bandwidth.
(Figure 14, Page 41) 60 db — 100 Kc maximum total bandwidth.

e. Remove all test equipment and replace all connections to Pin 2, V-103.

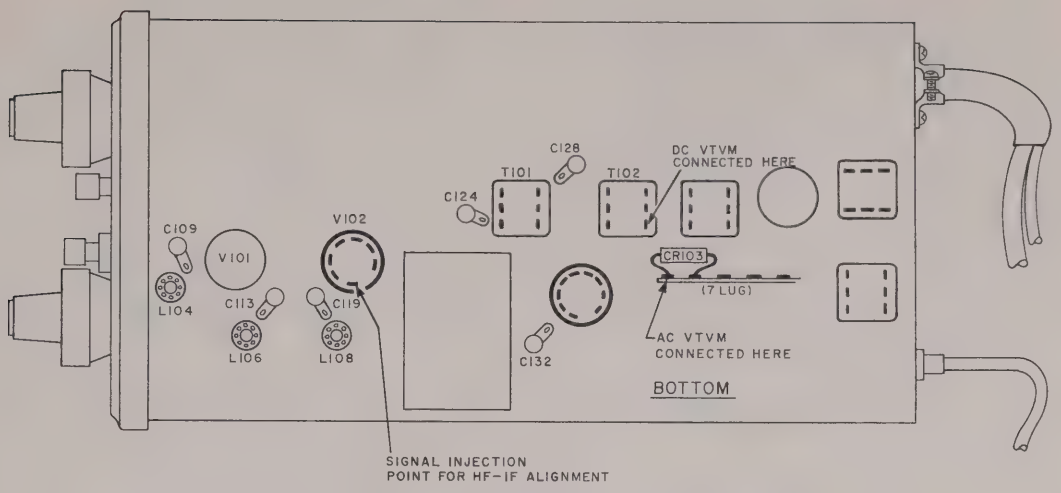


Figure 9.
COM RECEIVER TEST CONNECTIONS
HF IF and RF alignment.

5-F,3. HF IF Amplifier.

a. Connect an AC VTVM to the anode (unbanded) end of CR-103. Connect a DC VTVM to C-117.

b. Remove all connections from Pin 1, V-102. Connect a 47-ohm resistor from Pin 1, V-102, to ground. Connect a signal generator to Pin 1, V-102.

c. Set the fractional megacycle selector to the .00 position. Set the signal generator to 9.475 Mc/s. Increase the signal generator output to the lowest level which will provide a useable negative voltage indication on the DC VTVM. Adjust T-102 and the primary and secondary slugs of T-101 for maximum negative voltage indication on the DC VTVM. Reduce the signal generator level as necessary to maintain minimum useable negative DC Voltage indication. Several peaks may be observed as the slug of T-102 is adjusted. Use the peak position in which the slug is farthest from the chassis.

d. Set the fractional megacycle selector to the .90 position. Set the signal generator to 8.575 Mc/s. Adjust C-132, C-128 and C-124 for maximum negative DC voltage.

e. Repeat steps c., and d., until no further increase in negative DC voltage is obtained.

f. Modulate the signal generator 30% by 400 cps and check each fractional megacycle position for AC voltage on the AC VTVM. See Table V, page 38 for the HF intermediate frequency at each fractional Mc setting.

Normal Indication: 30 μv maximum for 0.4 VAC.

g. Remove the signal generator and 47-ohm resistor from Pin 1, V-102, and replace all connections.

5-F,4. RF Amplifier.

a. Connect an AC VTVM to the anode (unbanded) end of CR-103. Connect a DC VTVM to C-117.

b. Connect a VHF signal generator to J-101, the COM antenna connector.

CAUTION: DO NOT KEY THE TRANSMITTER! TRANSMITTER POWER MAY DAMAGE THE SIGNAL GENERATOR.

c. Set the channel selectors and the signal generator to 118.50 Mc/s. Increase the signal generator output to the lowest level which will produce a useable negative voltage indication on the DC VTVM. Adjust C-109, C-113, and C-119 for maximum negative DC voltage.

d. Set the channel selectors and the signal generator to 135.50 Mc/s. Adjust L-104, L-106, and L-108 for maximum negative DC voltage.

e. Repeat steps c., and d., until no further increase in negative DC voltage is obtained.

f. Modulate the signal generator 30% by 1000 cps. Set the channel selectors and signal generator to 118.50 Mc/s. Increase the signal generator level until the AC VTVM reads 0.4 VAC. Repeat this check with the channel selectors and the signal generator set at 135.50 Mc/s.

Normal Indication: 5 μv maximum input for 0.4 VAC.

5-F,5. Sensitivity and Audio Output.

a. Connect an audio wattmeter to the speaker output.

b. Connect VHF signal generator to J-101. Modulate the signal generator 30% by 1000 cps.

CAUTION: DO NOT KEY THE TRANSMITTER! TRANSMITTER POWER MAY DAMAGE THE SIGNAL GENERATOR.

c. Set the channel selectors and signal generator to 118.00 Mc/s. Set the COM volume control to the middle of its range. Set the NAV volume control fully counterclockwise and pull the knob. Adjust the signal generator output level to produce a 6 db (4:1) difference in audio power readings with and without modulation.

d. Set the COM volume control fully clockwise and adjust the signal generator level (modulated) to produce 3 watts of audio power.

e. Repeat steps c., and d., with the channel selectors and signal generator set at 126.50 and 135.95 Mc/s.

Normal Indication: 2 μv maximum for 6 db signal plus noise to noise at the speaker output.
5 μv maximum for 3 watts at the speaker output.

5-F,6. Squelch Compensation.

a. Connect the VHF signal generator to J-101, the COM antenna connector. Adjust the signal generator. Adjust the signal generator and the Mark-12A to the same frequency.

b. Turn the squelch knob fully counterclockwise (maximum squelch).

c. Increase the signal generator level from zero until audio is heard to break through.

Normal Indication: Input levels of 10 to 25 microvolts should break maximum squelch.

d. If signal level required to break maximum squelch is less than 10 microvolts, shunt R-131 as necessary to increase the level to more than 10 microvolts. If the squelch breaking level is greater than 25 microvolts, replace R-131 with a higher value resistance to reduce the level to less than 25 microvolts.

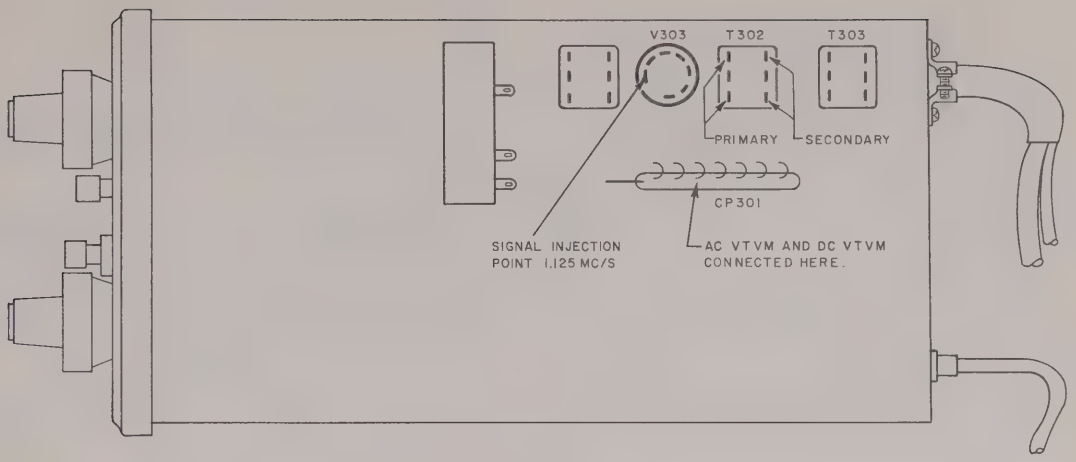


Figure 10.
NAV LF IF ALIGNMENT CONNECTIONS.

5-G. NAVIGATION RECEIVER ALIGNMENT.

5-G,1. Low Frequency IF Amplifier.

a. Connect an AC VTVM and a DC VTVM to lead 5 of CP-301.

b. Connect an RF-VTVM to the collector of Q-303.

c. Remove all connections from Pin 1, V-303. Connect a 47 ohm resistor from Pin 1 to ground, and connect a signal generator to Pin 1. Set the signal generator to 1.125 Mc/s.

d. Temporarily connect 33K resistors across the primary and secondary windings of T-302. Keep leads short to avoid coupling.

e. Increase the signal generator output to the lowest level which gives a usable negative DC voltage indication on the DC VTVM. Adjust both slugs of T-302 for maximum negative voltage indication, making certain each slug is in the peak position farthest from the center of the transformer. Adjust the primary (slug nearer the chassis) of T-303 for maximum negative DC voltage. Adjust the secondary (slug farther from the chassis) for *minimum* RF voltage on the RF VTVM. Repeat the adjustments of T-303 until maximum negative DC and minimum RF indications are obtained. Both slugs of T-303 must be in the peak positions farthest from the center of the transformer. The correct primary peak is very slight.

f. Remove the two 33K resistors from T-302. Modulate the signal generator 30% by 400 cps. Increase the signal generator output level until a reading of 1.9 volts is obtained on the AC VTVM.

Normal Indication: 200 μv maximum input for 1.9 VAC. (CN144A10, 350 uv max. input.)

g. Remove all test equipment and replace all connections to Pin 1, V-303.

5-G,2. LF IF Bandwidth.

a. Connect a DC VTVM and signal generator as described in steps a., and b., under G,1., above.

b. Adjust the signal generator output to the minimum level which produces a useable negative voltage indication on the DC VTVM. Vary the signal generator frequency across the LF IF passband. The negative voltage indication should peak approximately 10 Kc/s either side of the 1.125 Mc/s center frequency, with 1.125 Mc/s falling at the bottom of a slight dip. The DC VTVM reading at this dip is the reference for LF IF bandwidth measurements.

c. Increase the signal generator output level 6 db (2:1) above the level used in step b. Tune the signal generator above 1.125 Mc/s until the DC VTVM again shows the reference level, and note the frequency. Tune the signal generator below 1.125 Mc/s until the reference level is again reached and note the frequency. The difference between these two frequencies is the total 6 db bandwidth.

d. Increase the signal generator output level 60 db (1000:1) above the level used in step b. Tune the signal generator above and below 1.125 Mc/s until the reference level is reached, as in step c. The difference between these two frequencies is the total 60 db bandwidth.

Normal Indication: 6 db — 38Kc minimum total bandwidth.
(Figure 15, page 41) 60 db — 340 Kc maximum total bandwidth.

e. Remove all test equipment and replace all connections to Pin 1, V-303.

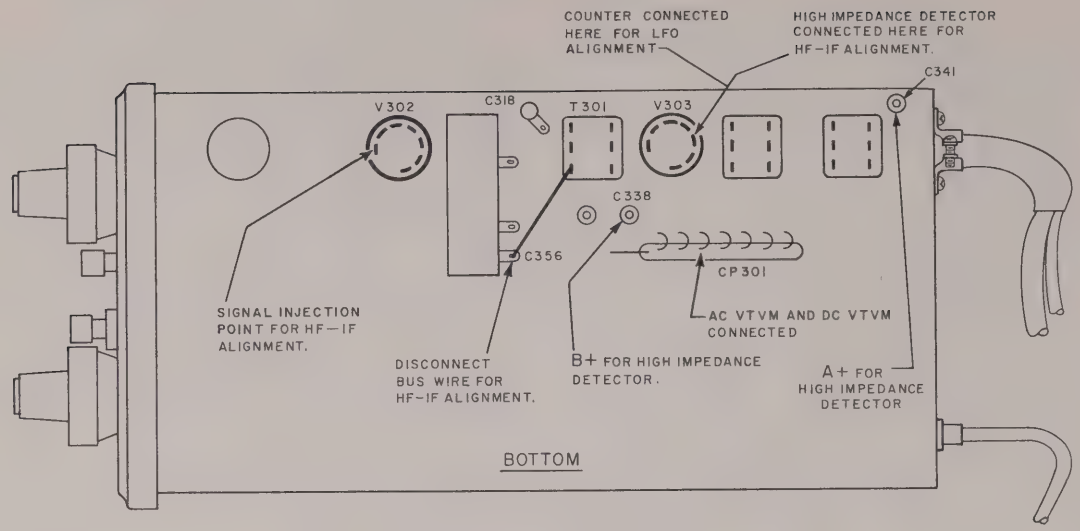


Figure 11.
NAV HF IF and LFO Alignment Connections.

5-G,3. HF IF Amplifier.

a. Disconnect Pin 5, V-303, from T-302. Connect a high-impedance detector (See Fig. 1, Page 17) as follows:
   Connect the B+ lead to C-338.
   Connect the plate lead to Pin 5, V-303.
   Connect the A+ lead to C-341.
   Connect the AC VTVM to the high impedance detector output.

b. Remove all connections from Pin 1, V-302. Connect a 47-ohm resistor from Pin 1, to ground, and connect a signal generator to Pin 1. Modulate the signal generator 30% by 400 cps.

c. Disconnect the buss wire from C-356, then ground the buss wire.

d. Set the fractional megacycle selector to the .9 position. Set the signal generator to 12.35 Mc/s and adjust its output level for a useable indication on the AC VTVM. Adjust both slugs of T-301 for maximum indication on the AC VTVM.

e. Set the fractional megacycle selector to the .0 position. Set the signal generator to 11.45 Mc/s. Adjust C-318 for maximum indication on the AC VTVM.

f. Repeat steps d. and e., until no further increase in AC VTVM indication is obtained.

g. Check the signal generator frequency at which the maximum indication on the AC VTVM is obtained on each fractional megacycle selector position. This frequency should be no more than ±15 Kc from the center frequency given in table VI.

h. Disconnect all test equipment and replace all connections to V-302, V-303 and C-356.

5-G,4. Low Frequency Oscillator.

PRIMARY METHOD

Procedure:

a. Determine that the HF IF is properly aligned.

b. Disconnect Pin 5, V-303 from T-302. Connect a 39 μhy choke from Pin 6, V-303 to Pin 5, V-303. Connect a 47 pf 500V capacitor from Pin 5, V-303 to the input of the frequency counter. Remove all connections from Pin 1, V-302.

c. Set L-314 to mid-range. (Tuning screw half way in). Set C-345 to mid-range. (Slot for tuning tool parallel to the chassis).

d. Set the fractional Mc selector to the .9 position. Observe the frequency indicated on the counter. Adjust L-314 for an indication of 11.225 Mc on the counter.

e. Set the fractional Mc selector to the .0 position. Observe the frequency indicated on the counter. Adjust C-345 for an indication of 10.325 Mc on the counter.

f. Repeat steps d. and e. until the circuit is tracked. Check the frequency of each fractional Mc position. The frequency must be within ±8 Kc of the center frequency of each position. See Table IV, page 37.

g. Reconnect the components previously removed from Pin 1, V-302. Remove the counter, 47 pf capacitor, and 39 μhy choke from Pin 5 and Pin 6 of V-103. Reconnect Pin 5, V-303 to T-302.

ALTERNATE METHOD

Procedure:

a. Calibrate a BC-221 frequency meter to the nearest crystal check point related to the 10 Mc through 11 Mc range.

b. Connect a length of insulated wire (#22 hook up wire is adequate) to the antenna post of the BC-221. Insert the other end of the wire into the plate and screen area of V-303. Take care that the wire is well away from the control grid area of V-303 or oscillator frequency pulling will be experienced.

c. Set the fractional Mc selector to the .9 position. Set the BC-221 to 11.225 Mc. Adjust L-314 for a zero beat from the BC-221.

d. Set the fractional Mc selector to the .0 position. Set the BC-221 to 10.325 Mc. Adjust C-345 for a zero beat from the BC-221.

e. Repeat steps c. and d. until the circuit is tracked. Check the frequency of each fractional Mc position. The frequency must be within ±8 Kc of the center frequency for each position.

Normal Indication:

Each fractional Mc position must be no more than ±8 Kc from its center frequency.

5-G,5. Overall IF Gain.

a. Connect an AC VTVM to lead 5 of CP-301.

b. Remove all connections from Pin 1, V-302. Connect a 47 ohm resistor from Pin 1 to ground and connect a signal generator to Pin 1. Modulate the signal generator 30% by 1000 cps.

c. Set the fractional Mc selector to each of the following positions, and the signal generator to the corresponding frequency. Note the input required to produce 1.9 VAC on the AC VTVM at each frequency.

Fractional Mc Selector	Signal Generator Frequency
.0	11.45 Mc/s
.5	11.95 Mc/s
.9	12.35 Mc/s

Normal Indication: 20μv maximum input for 1.9 VAC detector output.

d. Remove all test equipment and replace all connections to Pin 1, V-302.

5-G,6. High Frequency Oscillator.

a. Connect a RF VTVM probe to Pin 1, V-302.

b. Set the megacycle selector to the 108 position. Adjust C-345 for maximum RF voltage indication.

c. Set the megacycle selector to the 117 position. Adjust L-310 for maximum RF voltage indication.

d. Repeat steps b., and c., until no further increase in RF voltage indication is obtained.

e. Check to insure that the oscillator is operating in each megacycle position. Operation is indicated by a normal RF indication.

Normal Indication: 0.5 V RMS Nominal.
0.3 V RMS Minimum.

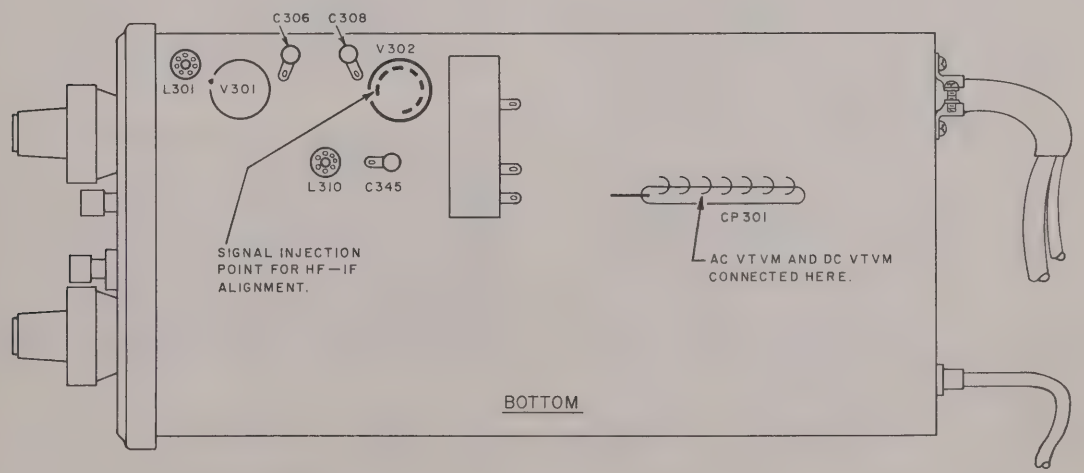


Figure 12
NAV HFO and RF Alignment Connections.

5-G,7. RF Amplifier.

a. Connect an AC VTVM and a DC VTVM to lead 5 of CP-301.

b. Connect a VHF signal generator to J-301.

c. Set the channel selectors and signal generator to 108.5 Mc/s. Increase the signal generator output to provide a useable negative voltage indication on the DC VTVM. Adjust C-306 and C-308 for maximum negative DC voltage.

d. Set the channel selectors and signal generator to 117.5 Mc/s. Adjust L-301 for maximum negative DC voltage.

e. Repeat steps c., and d., until no further increase in negative DC voltage is obtained.

f. Modulate the signal generator 30% by 1000 cps. Check the input level required to produce 1.9 VAC on the AC VTVM at 108.0, 112.5 and 117.9 Mc/s.

Normal Indication: 2.5 μv maximum input for 1.9 VAC.

5-G,8. Sensitivity and Audio Output.

a. Connect an audio wattmeter to the speaker output.

b. Connect the signal generator to J-301. Modulate the signal generator 30% by 1000 cps.

c. Set the NAV volume control to the middle of its range, and pull the knob. Set the COM volume control fully counterclockwise. Set the channel selector and signal generator to 108.0 Mc/s. Adjust the signal generator output level so the audio wattmeter reading with modulation is 6 db (4:1) greater than the reading without modulation.

d. Repeat step c., with channel selector and signal generator set at 112.5 Mc/s and 117.9 Mc/s.

Normal Indication: 2μv maximum input for 6 db signal plus noise to noise at speaker output.

e. Turn the NAV volume control fully clockwise. Adjust the signal generator output level to provide 4.5 watts audio output with the channel selectors and signal generator set at 108.0, 112.5 and 117.9 Mc/s.

Normal Indication: 3 μv maximum input for 4.5 watts at speaker output.

5-G,9. Ident. Filter Alignment.

a. Connect an audio wattmeter to the speaker output.

b. Connect a VHF signal generator to J-301. Modulate the signal generator 30% by 1020 cps.

c. Set the channel selectors and signal generator to 117.5 Mc/s. Set the signal generator output level to 500 μv. Pull the NAV volume control knob and adjust it for 3 watts on the audio wattmeter. Push the NAV volume control knob in and adjust L-317 for a minimum indication on the audio wattmeter.

Normal Indication: Audio level should be 50 mw maximum at speaker output with NAV volume control knob pushed in.

5-H. MODULATOR-POWER UNIT.

The only control requiring adjustment is the microphone gain control. It is adjusted at the factory for normal carbon microphones, and should need adjustment only if the MK-12A is to be used with a microphone providing a higher output level. If adjustment is required, proceed as follows:

5-H,1. Recommended Method (Bench Adjustment).

Connect the Mark 12A and T (- -) MP-12A to a primary power source. Connect the microphone to the modulator/power and accessory cable. Connect an oscilloscope to C-205 (feed-thru capacitor in left front corner of chassis.)

Connect a 50 ohm, 10 watt, dummy load to the COM antenna jack. If possible, have the pilot speak into the microphone in his normal manner. Turn the gain control fully counterclockwise. Key transmitter and, while speaking into the microphone, adjust the gain control until the positive and negative voice peaks, viewed on the oscilloscope, begin flattening.

5-H,2. Alternate Method (Adjustment in Aircraft).

Connect the microphone to the Mark 12A. Connect the common lead of a Simpson Model 260 VOM, or equivalent, to the Mark 12A chassis. Connect the probe to C-205, (feedthru capacitor in left front corner of the chassis). Set the VOM function selector to "output." Key the transmitter, and while speaking a sustained "ah" into the microphone, adjust the gain control for a reading of 60 to 75 volts on the VOM.

5-I. CONVERSION, 90 to 360 COMMUNICATION CHANNELS.

Caution: The Mark-12A conversion kit, ***narco*** No. EL-3077-503, must be used for this conversion. Mark-12 conversion kits, ***narco*** No. EL-2051, are not acceptable, owing to a different crystal correlation, even though the frequencies stamped on the crystals are the same as those in the Mark-12A kit.

The proper Mark-12A COM HFO crystals bear correlation letters QQ. Mark-12A COM LFO crystals bear correlation letters RR.

5-I,1. Fractional Megacycle Crystals.

a. Installation.

This kit contains ten crystals which are to be installed in the low frequency oscillator crystal assembly. The LFO crystal assembly is located just to the rear of V-103 and V-204. It will be noted that this assembly contains crystals in every other crystal position only on both the top and bottom sides of the chassis.

Viewed from the top, front, install the highest frequency crystal of this kit (9.425 Mc) in the vacant crystal space on the extreme left—*nearest chassis edge*. NOTE: Descending crystal oscillator operating frequency is ascending channel selector frequency; i.e., 9.475 Ms = .00, 8.525 Mc = .95. Install the remaining crystals, in descending frequency order, in the vacant crystal spaces working from left to right. When the top row is completed, five crystals should have been used.

Turn the chassis over. Install the remaining five crystals in the open crystal spaces in the bottom row. Viewed from the bottom, front, install the crystals in descending frequency order working from left to right. Use care in soldering crystal leads to prevent heat damage to the crystal. Do not bend crystal leads at a right angle at the point where they emerge from the crystal case. This could fracture the glass seal.

b. Detent Arrangment.

The fractional Mc detent is located at the rear of the chassis on the top side to the left of T-105 between T-101 and T-102. It will be noted that this detent has a star wheel on each end. On the one end, toward the front of the unit, is a ten position star wheel; on the other end, toward the rear of the unit, a twenty position star wheel. This detent must be reversed, or turned around, so that the twenty position star wheel is toward the front of the unit.

The detent is secured by two screws, and it can be removed from its mounting shaft when these screws are loosened. Before removing the detent, set the fractional Mc selector to a position where the rotor tabs of the crystal assembly or of the HF IF step inductors can be observed. Note, at the same time, the frequency indicated by the fractional Mc dial. This is necessary so that proper indexing can be re-established easily.

Remove the detent spring and the detent roller from the detent assembly. Then loosen the two set screws in the dual star wheel assembly and slide the assembly to the rear of the Unit and off the shaft. In the event there is insufficient space to completely remove the star wheel assembly from the shaft, it will be necessary to remove the "COM" Fractional Mc Knob and loosen the set screws securing the Fractional Mc dial to its shaft. The fractional Mc shaft can then be moved forward enough to remove the star wheel assembly. Turn the star wheel assembly end for end so that the twenty position star wheel is toward the front of the unit, then slide it back on its shaft. Now replace the detent roller and detent spring. Note that the long end of the detent spring shall be retained in position, by placing this end on the inside of the outermost tab on the detent mounting plate. Check the rotor tabs at the chosen reference point for indexing, then secure the set screws in the star wheel assembly. Provide about .005 inch end play between the star wheel assembly and the bushing in the detent mounting plate. If the Fractional Mc Knob and dial have been loosened, re-secure them in their proper position as noted above.

After the final check of the assembly, a small amount of wide temperature range grease should be applied to the spring fulcrum, roller, and star wheel detent teeth.

5-I,2. Whole Megacycle Crystals.

a. Installation.

This kit contains nine crystals which are to be installed in the high frequency oscillator crystal assembly. Viewed from the top, front, the HFO assembly is located on the left side approximately midway between the front and rear of the chassis. It is enclosed in a box. Remove the top and the bottom covers. Each is held in place by two machine screws.

Viewed from the front, top side, it will be noted that the HFO crystal assembly has three empty crystal spaces to the left of its top center, and six empty crystal spaces to the right of its top center. Install these nine crytals in these spaces, in ascending frequency order working from left to right. Ue care in soldering crystal leads to prevent heat damage to the crystal. It may be necessary to remove C-251 and L-218 to install crystals in the last two spaces.

b. Stop Removal.

The top on the Mc selector detent plate at the 126 position must now be broken out. To gain access to this stop, the knobs, mask, and trim panel must be removed. Before disassembly of the front panel, it is well to set the selectors to a reference frequency position for re-assembly. Removal of the front panel assembly will reveal the detent plate, The stop will be located on the rear side at the bottom and center of the detent plate. The stop is merely a lance, approximately 1/16 of an inch wide, in the detent plate itself. Break this stop out, and the Mc selector will channel to the 135 position. Exercise care that the channel selectors indicate the proper channel when the front panel is reassembled.

5-I,3. Post Conversion Check-out.

After the crystals are installed, the detents properly adjusted, and the HFO covers re-assembled, give the radio and operational performance check. Alignment of the HFO, the transmitter, and the receiver RF section should be checked. In the event realignment is necessary, refer to the appropriate part of the alignment procedure section of the ***narco*** Mark-12A Instruction Manual. A new frequency check slip is required for the transmitter which reflects the original plus the new channels that have been activated.

HFO frequency may be checked by inserting a long, slim one-turn pickup loop through one of the trimmer access holes in the oscillator side of the HFO box. LFO frequency may be checked by holding a pickup loop near T-201. LFO frequency should be checked in transmit mode.

5-J. SELECTED COMPONENTS.

The values of two capacitors in the Mark-12A are selected for proper circuit operation.

C-331 is selected to adjust the coupling between windings of T-302, to control the bandwidth of the NAV receiver. Increasing C-331 narrows the receiver bandwidth. This capacitor should range from 0 to 1.5 pF. See Par. 5-G,2, page 29 for bandwidth measurement techniques.

C-335 is selected to permit proper tracking of the NAV low-frequency oscillator. In aligning this oscillator, C-353 may be found to have sufficient range for tracking. The value of C-355 may then be increased or decreased to permit tracking. See Par. 5-G,4, page 30, for NAV LFO alignment procedure.

A resistor may be shunted across R-131, or the value of R-131 may be greater than 33K in some cases. The value of R-131 is thus adjusted for proper squelch operation. See Par. 3-F,6, page 28, for squelch compensation procedure.

5-K. PRODUCTION CHANGES.

5-K,1. Introduction.

The information in this manual is specifically applicable to Mark-12A panel units with chassis number CN144A11. Minor electrical and mechanical differences will be found between the chassis and earlier production units. The following table lists these differences. "X" indicates that a particular chassis will have the indicated circuit changes descibed in the first column.

5-K,2. Table of Chassis Differences.

CURRENT CIRCUIT	Chassis Number CN144											REMARKS
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	
C-236 (33pF dipped mica from Q-203 collector to ground) and L-224 (5.6 μhy between Q-203 collector and T-201) added.	X	X	X	X	X	X	X	X	X	X	X	May be added if internal COM heterdoyne is noted when tuning variable - frequency generator through COM channel.
C-118 changed from .33 pF to .22pF.	—	X	X	X	X	X	X	X	X	X	X	.22pF may be installed to improve COM high frequency image rejection.
C-326 changed from .003 to .01.	—	X	X	X	X	X	X	X	X	X	X	.01 may be installed to suppress power supply harmonics in NAV receiver.
R-333 changed from 22K to 15K.	—	X	X	X	X	X	X	X	X	X	X	15K may be installed to increase NAV output level.
Q-203 Circuit Changes.	—	—	—	—	—	—	—	X	X	X	X	See Fig. 29.
	X	—	—	—	—	—	—	—	—		—	See Fig. 29A.
	—	X	X	X	X	X	X	—	—		—	See Fig. 29B.
R-138 and C-171 added.	—	—	X	X	X	X	X	X	X	X	X	These components may be installed to correct an intermittent COM receiver
Case grounding clip mounted on shield at V-101 socket.	—	—	X	X	X	X	X	X	X	X	X	Clip may be installed to suppress regeneration in COM receiver front end. This may appear to be case noise.
C-131 changed from 2.2 pF to 8.2 pF and C-168 changed from 4.7 pF to 8.2 pF.	—	—	—	X	X	X	X	X	X	X	X	These values may be changed to improve COM low-frequency image rejection.

5-K,2. Table of Chassis Differences (Continued)

CURRENT CIRCUIT	Chassis Number CN144											REMARKS
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	
R-139 added to radio.	—	—	—	X	X	X	X	X	X	X	X	May be added to stop audio squeal when COM receiver is first turned on.
C-246 changed from .01 to 430 pF and L-225 added.	—	—	—	—	—	X	X	X	X	X	X	C-246 may be changed and L-225 added to prevent harmonics of COM LFO from interfering with NAV receiver.
C-370 and R-340 added.	—	—	—	—	—	X	X	X	X	X	X	May be added to reduce heterodynes produced in COM receiver by harmonics of NAV HFO
R-340 changed from 100 ohms to 150 ohms.	—	—	—	—	—	—	X	X	X	X	X	R-340 may be changed to 150 ohms to further suppress NAV HFO harmonics (see above)
White/blue wire from CR-104 to CP-302, lead 4, instead of shielded lead.	—	—	—	—	—	—	—	—	X	X	X	White / blue wire may be disconnected and replaced with shielded lead, shield grounded at diode end only, to reduce audio whine produced by alternator.
C-362 (Part #21552-1) and R-341 (Part #3114-151) added in parallel between CP-302, pin 1 and V-103, pin 8. R-342 Part #31192-220) added from junction of C-329 and C-330 to junction of R-312 and Q-302 emitter.	—	—	—	—	—	—	—	—	—	X	X	C-362 and R-341 may be added to reduce the audio gain dropoff at high temperatures. R-342 may be added to reduce NAV IF noise.
R-301 replaced by L-318 (0.047μH). C-303 changed to 27 pF. L-316 changed to 0.047μH.	—	—	—	—	—	—	—	—	—	—	X	Antenna filter revised between J-301 and L-301 to improve signal to noise ratio in NAV receiver.

SECTION 6

ILLUSTRATIONS

6-A. INTRODUCTION.

This section contains the Tables, Diagrams and Photos that have not been integrated with the text in the various sections.

The Panel and Power Unit Schematics are in the form of "pullout sheets" which can be used while the pages of the text, illustrations, or parts list are open for use.

6-B. TABLES

TABLE I

CRYSTAL FREQUENCY — HFO COMMUNICATION TRANSCEIVER

Channel	Oscillator Fundamental Frequency (Mc)	Oscillator Doubler Frequency (Mc)
117	63.2375	126.475
118	63.7375	127.475
119	64.2375	128.475
120	64.7375	129.475
121	65.2375	130.475
122	65.7375	131.475
123	66.2375	132.475
124	66.7375	133.475
125	67.2375	134.475
126	67.7375	135.475
127	68.2375	136.475
128	68.7325	137.475
129	69.2375	138.475
130	69.7375	139.475
131	70.2375	140.475
132	70.7375	141.475
133	71.2375	142.475
134	71.7375	143.475
135	72.2375	144.475

TABLE II

CRYSTAL FREQUENCY — LFO COMMUNICATION TRANSCEIVER

Channel	Transmit Crystal Frequency (Mc)	Receive Crystal Frequency (Mc)
.00	9.475	8.975
.05	9.425	8.925
.10	9.375	8.875
.15	9.325	8.825
.20	9.275	8.775
.25	9.225	8.725
.30	9.175	8.675
.35	9.125	8.625
.40	9.075	8.575
.45	9.025	8.525
.50	8.975	9.475
.55	8.925	9.425
.60	8.875	9.375
.65	8.825	9.325
.70	8.775	9.275
.75	8.725	9.225
.80	8.675	9.175
.85	8.625	9.125
.90	8.575	9.025
.95	8.525	9.025

TABLE III

CRYSTAL FREQUENCY — HFO NAVIGATION RECEIVER

Channel	Crystal Frequency (Mc)
108	96.55
109	97.55
110	98.55
111	99.55
112	100.55
113	101.55
114	102.55
115	103.55
116	104.55
117	105.55

TABLE IV

NAV Low Frequency Oscillator Frequencies

Channel	Frequency (Mc/s)
.0	10.325
.1	10.425
.2	10.525
.3	10.625
.4	10.725
.5	10.825
.6	10.925
.7	11.025
.8	11.125
.9	11.225

TABLE V

COM High Frequency Channel	Intermediate Frequencies.
.00	9.475
.05	9.425
.10	9.375
.15	9.325
.20	9.275
.25	9.225
.30	9.175
.35	9.125
.40	9.075
.45	9.025
.50	8.975
.55	8.925
.60	8.875
.65	8.825
.70	8.775
.75	8.725
.80	8.675
.85	8.625
.90	8.575
.95	8.525

TABLE VI

NAV High Frequency Channel	Intermediate Frequencies. Center Frequency (Mc/s)
.0	11.45
.1	11.55
.2	11.65
.3	11.75
.4	11.85
.5	11.95
.6	12.05
.7	12.15
.8	12.25
.9	12.35

TABLE VII

P-301 Terminal	Wire	Wire	Circuit
No.	Color	Size	Function
1	Grey	#18	Ground
2	Black	#18	+ DC Supply
3	No. Conn.	—	—
4	White/ Blue Tr.	#22	Omni/Loc. Relay
5	Blue	#22	Est. Dim. for VOR
6	Green	#22	Omni Signal

Frequency (Mc)	CONNECTOR PIN No. (P-202)									
	Fractional Mc. (S-310B)					Whole Mc (S-309)				
	F	H	J	K	L	D	A	E	C	B
108. 108.1	 X	X X			X			X X		X X
108.2 108.3	X	 X	X X					X X		X X
108.4 108.5		X	 X	X X				X X		X X
108.6 108.7			X	 X	X X			X X		X X
108.8 108.9	X X			X	 X			X X		X X
109. 110.		X X			X X		X X		 X	X
111. 112.		X X			X X	 X			X	X X
113. 114.		X X			X X	X		 X	X X	
115. 116.		X X			X X	X X	 X	X		
117. 118.		X X			X X		X	X X		

NOTES

1. Fractional Megacycle sequence (S-301B, 0.1 to 0.9 Mc) repeated for each Mc from 108 to 118 Mc.
2. X signifies that the circuit is at ground potential.

Table .....Channel Selector ground circuits, DME (S-309, S-310B).

Table VIII.
Channel Selector Ground Circuits, DME (S-309, S-310B).

NAV Channel (Mc)	Glide Slope Channel (Mc)	CONNECTOR NO.											
		P-301	P-201										
		4	B	E	A	D	H	L	P	R	N	K	F	C
108.0	—			X										
108.1	334.7	X	X	X	X									
108.2	—			X										
108.3	334.1	X	X	X		X								
108.4	—			X										
108.5	329.9	X	X	X			X							
108.6	—			X										
108.7	330.5	X	X	X				X						
108.8	—			X										
108.9	329.3	X	X	X					X					
109.0	—													
109.1	331.4	X	X							X				
109.2	—													
109.3	332.0	X	X								X			
109.4	—													
109.5	332.6	X	X									X		
109.6	—													
109.7	333.2	X	X										X	
109.8	—													
109.9	333.8	X	X											X
110.0	—													
110.1	334.4	X	X		X									
110.2	—													
110.3	335.0	X	X			X								
110.4	—													
110.5	329.6	X	X				X							
110.6	—													
110.7	330.2	X	X					X						
110.8	—													
110.9	330.8	X	X						X					
111.0	—			X										
111.1	331.7	X	X	X						X				
111.2	—			X										
111.3	332.3	X	X	X							X			
111.4	—			X										
111.5	332.9	X	X	X								X		
111.6	—			X										
111.7	333.5	X	X	X									X	
111.8	—			X										
111.9	331.1	X	X	X										X
112.	—			X*	SEE NOTE BELOW									
113.	—			X*										
114.	—			X*										
115.	—													
116.	—													
117.	—													
118.	—													

NOTES

1. X signifies that the circuit is at ground potential.
2. Since P-301/4 and P-201/B (Columns 3 & 4) control the OMNI/LOC and G/S circuits, they are not grounded when the channel selectors are set above 111.9 Mc. There is grounding of the remaining pins of P-201 as the channel changes are made; however they can be disregarded since the activate leads are not grounded above 111.9 Mc.

Table IX.
Channel Selector Ground Circuits, OMNI/LOC and Glide Slope
(S-310A, S-305A & B, S-312A & B)

6-C. DIAGRAMS.

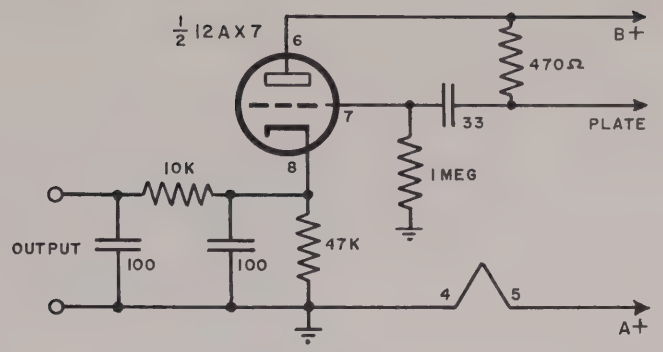


Figure 13.
TEST DETECTOR, High Impedance Type.

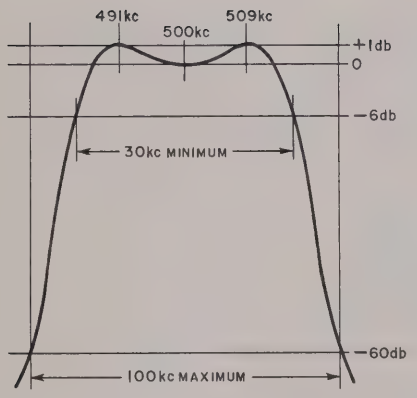


Figure 14.
COM LF IF PASSBAND.

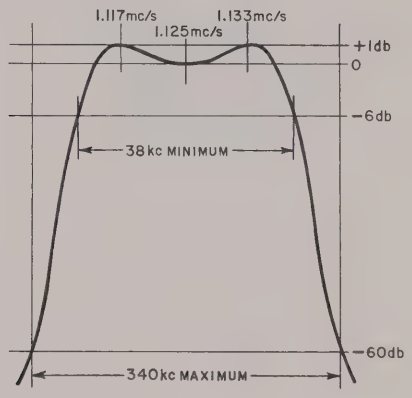
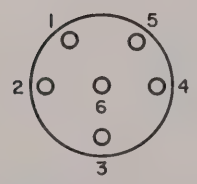
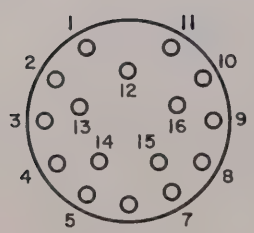


Figure 15.
NAV LF IF PASSBAND.



P301
FEMALE CONNECTOR
ON
PANEL UNIT PIGTAIL



P101
MALE CONNECTOR
ON
PANEL UNIT PIGTAIL

Figure 16.
CONNECTOR PIN IDENTIFICATION.

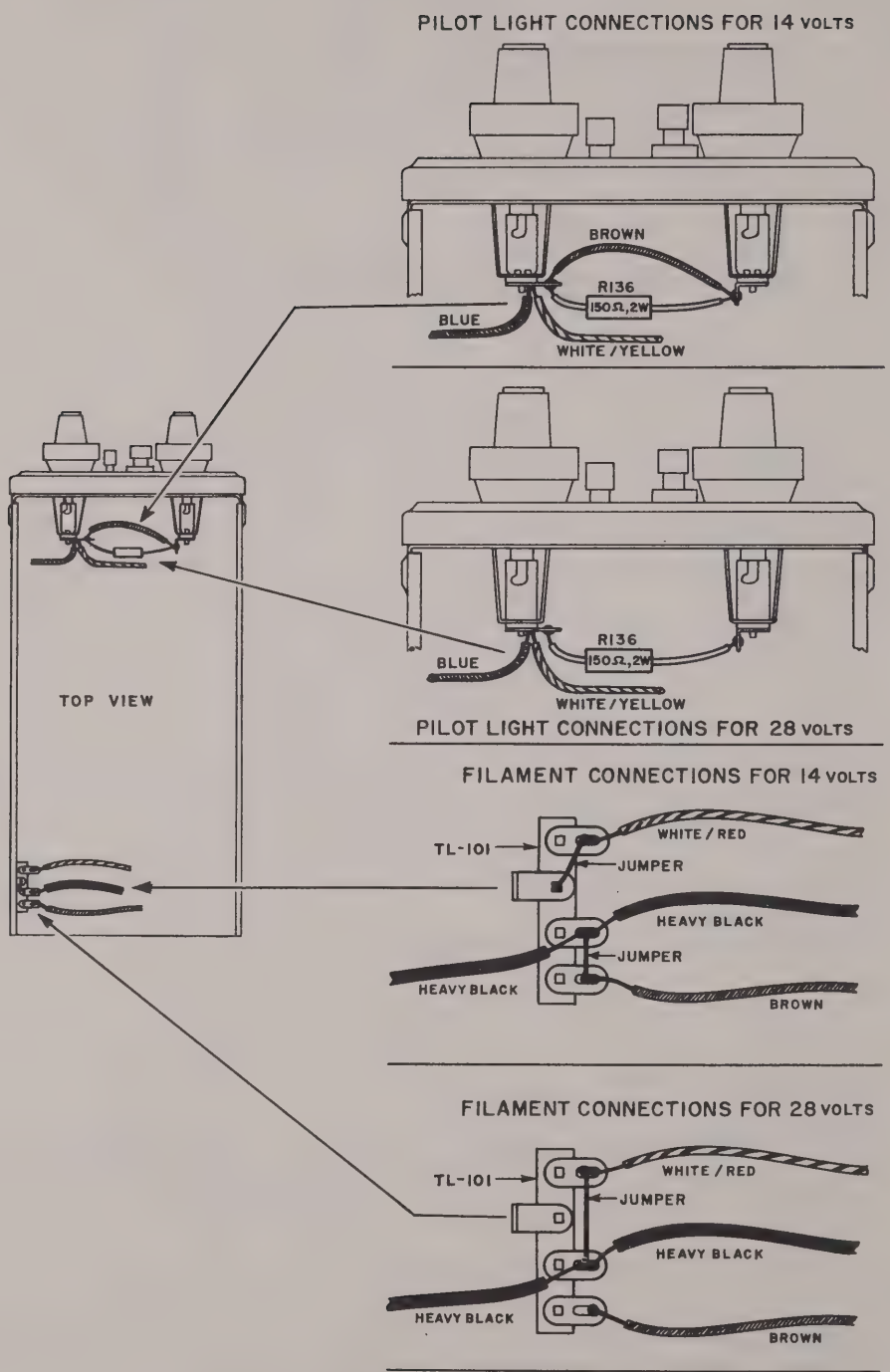


Figure 17.
Voltage Changeover Connections.

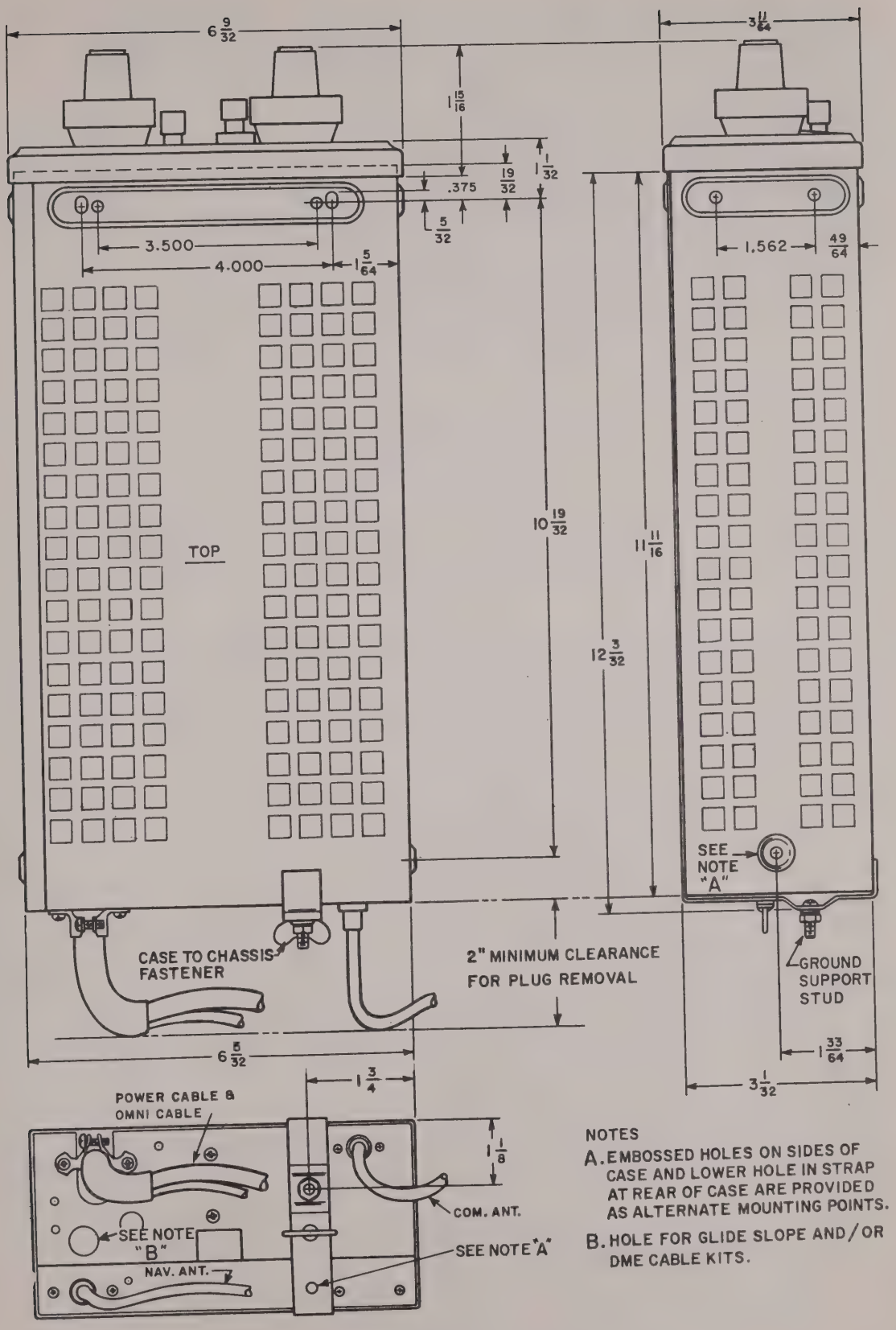


Figure 18.
narco Mark 12A PANEL UNIT,
Installation Diagram.

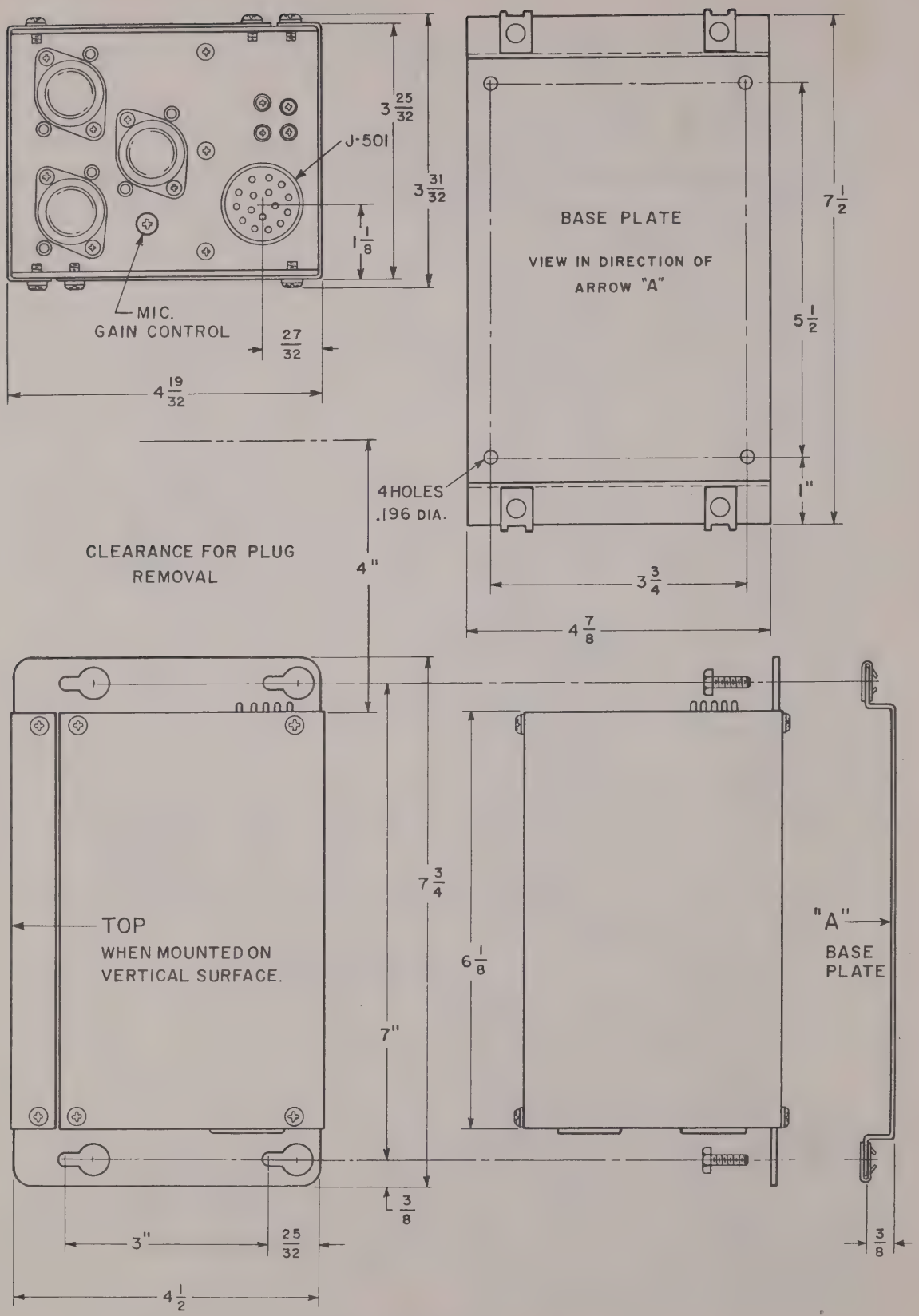


Figure 19.
narco T12MP-12A or T24MP-12A Modulator-Power Unit,
Installation Diagram.

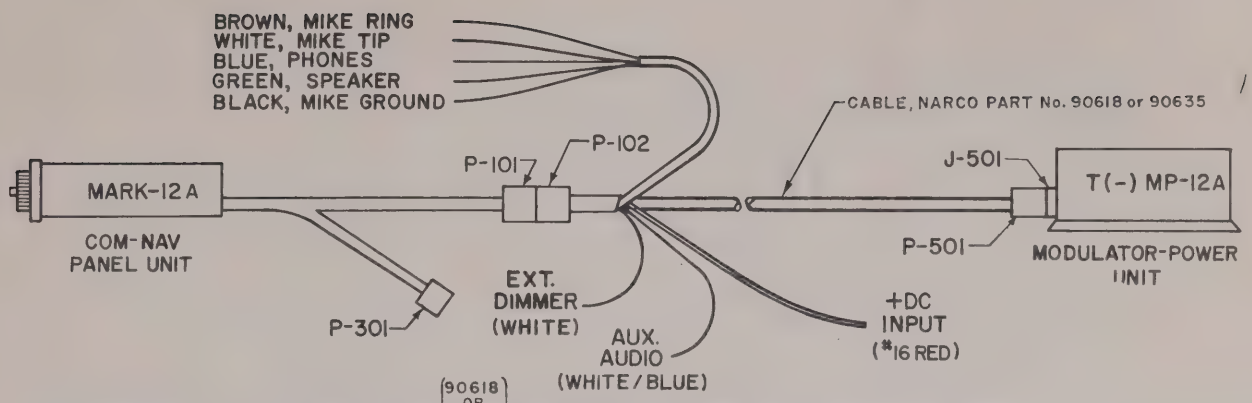

BROWN, MIKE RING
WHITE, MIKE TIP
BLUE, PHONES
GREEN, SPEAKER
BLACK, MIKE GROUND
CABLE, NARCO PART No. 90618 or 90635
P-101
P-102
J-501
T(-) MP-12A
MARK-12A
COM-NAV PANEL UNIT
P-501
MODULATOR-POWER UNIT
EXT. DIMMER (WHITE)
+DC INPUT (*16 RED)
P-301
AUX. AUDIO (WHITE/BLUE)
NOTE - CONNECTORS ON BOTH ENDS OF CABLE (90618 OR 90635) ARE ALIKE BUT EQUIPMENT WILL OPERATE ONLY WHEN CABLE IS INSTALLED AS SHOWN, WITH POWER AND ACCESSORY WIRES AT PANEL UNIT END.

Figure 20.
narco Mark 12A Interconnecting Cable,
Power and Accessories.

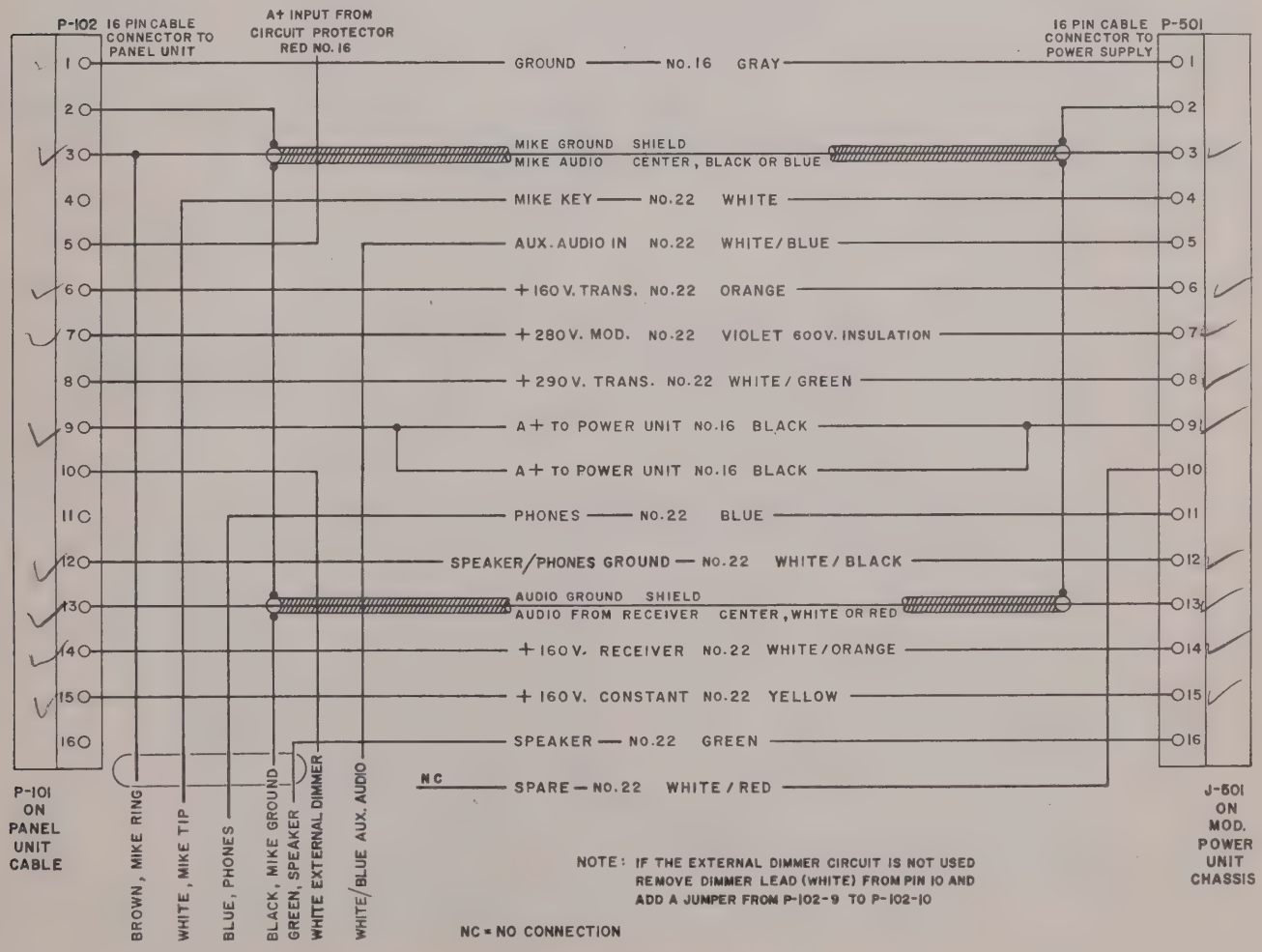

P-102 16 PIN CABLE CONNECTOR TO PANEL UNIT
A+ INPUT FROM CIRCUIT PROTECTOR RED NO. 16
16 PIN CABLE CONNECTOR TO POWER SUPPLY
P-501
GROUND — NO.16 GRAY
MIKE GROUND SHIELD
MIKE AUDIO CENTER, BLACK OR BLUE
MIKE KEY — NO.22 WHITE
AUX. AUDIO IN NO.22 WHITE/BLUE
+160 V. TRANS. NO.22 ORANGE
+280 V. MOD. NO.22 VIOLET 600V. INSULATION
+290 V. TRANS. NO.22 WHITE/GREEN
A+ TO POWER UNIT NO.16 BLACK
A+ TO POWER UNIT NO.16 BLACK
PHONES — NO.22 BLUE
SPEAKER/PHONES GROUND — NO.22 WHITE/BLACK
AUDIO GROUND SHIELD
AUDIO FROM RECEIVER CENTER, WHITE OR RED
+160 V. RECEIVER NO.22 WHITE/ORANGE
+160 V. CONSTANT NO.22 YELLOW
SPEAKER — NO.22 GREEN
NC
SPARE — NO.22 WHITE/RED
P-101 ON PANEL UNIT CABLE
J-501 ON MOD. POWER UNIT CHASSIS
BROWN, MIKE RING
WHITE, MIKE TIP
BLUE, PHONES
BLACK, MIKE GROUND
GREEN, SPEAKER
WHITE EXTERNAL DIMMER
WHITE/BLUE AUX. AUDIO
NOTE: IF THE EXTERNAL DIMMER CIRCUIT IS NOT USED REMOVE DIMMER LEAD (WHITE) FROM PIN 10 AND ADD A JUMPER FROM P-102-9 TO P-102-10
NC = NO CONNECTION

Figure 21.
narco Mark 12A CABLE CONNECTIONS,
Power and Accessories.

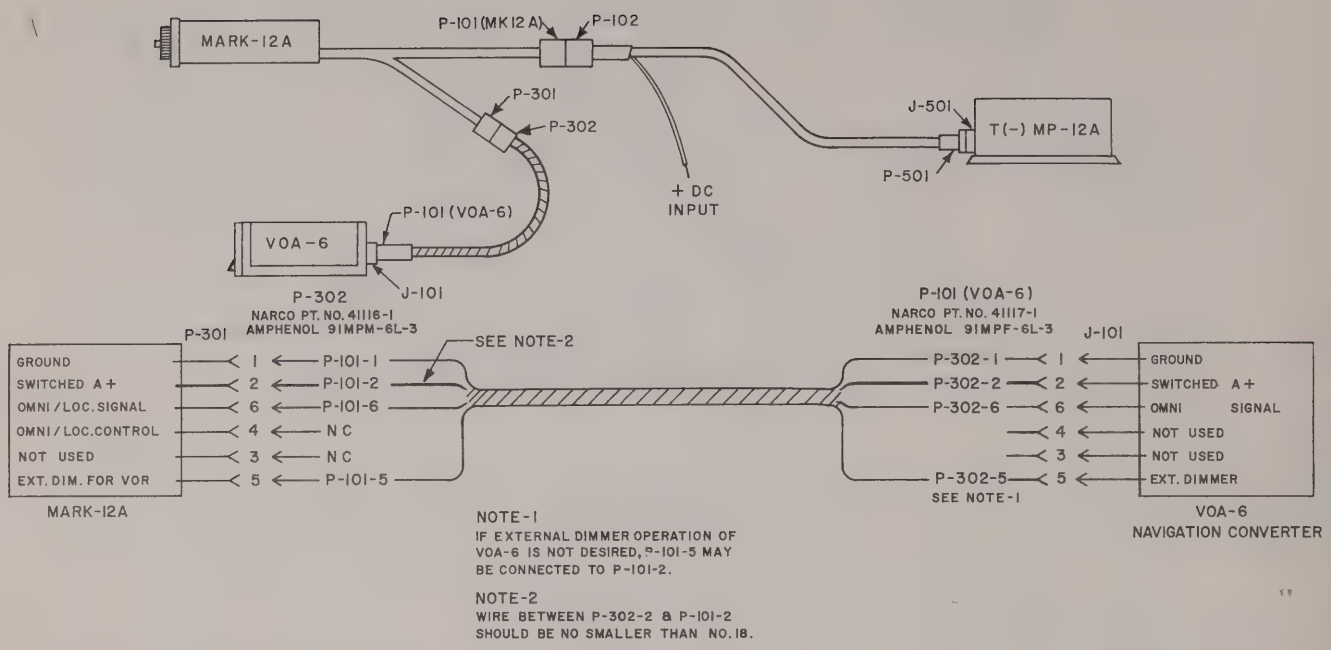


Figure 22.
INTERCONNECTIONS.
narco Mark 12A COM/NAV EQUIPMENT with
narco VOA-4 NAV CONVERTER.

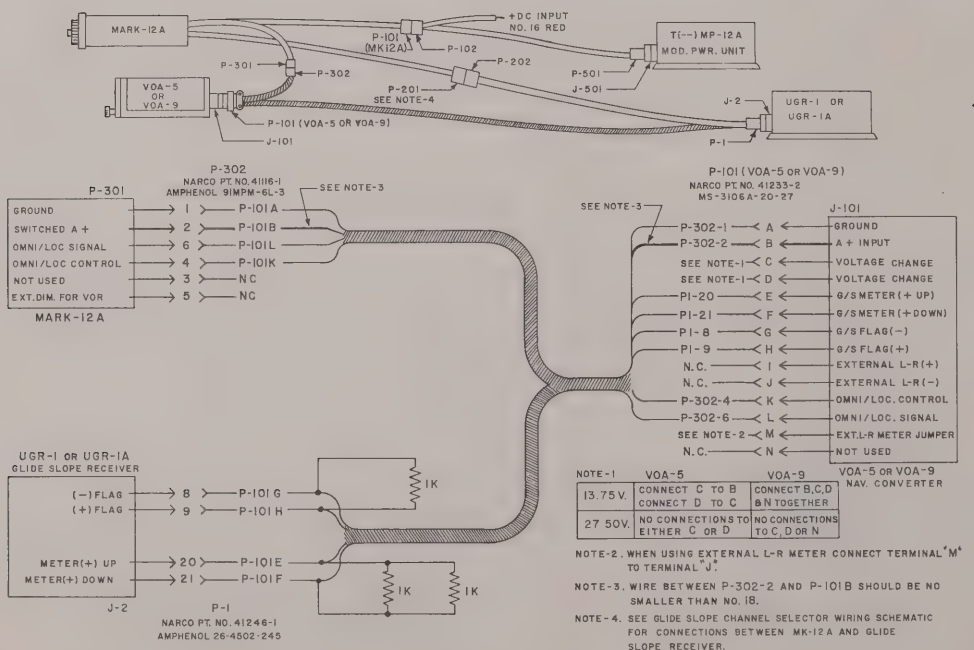
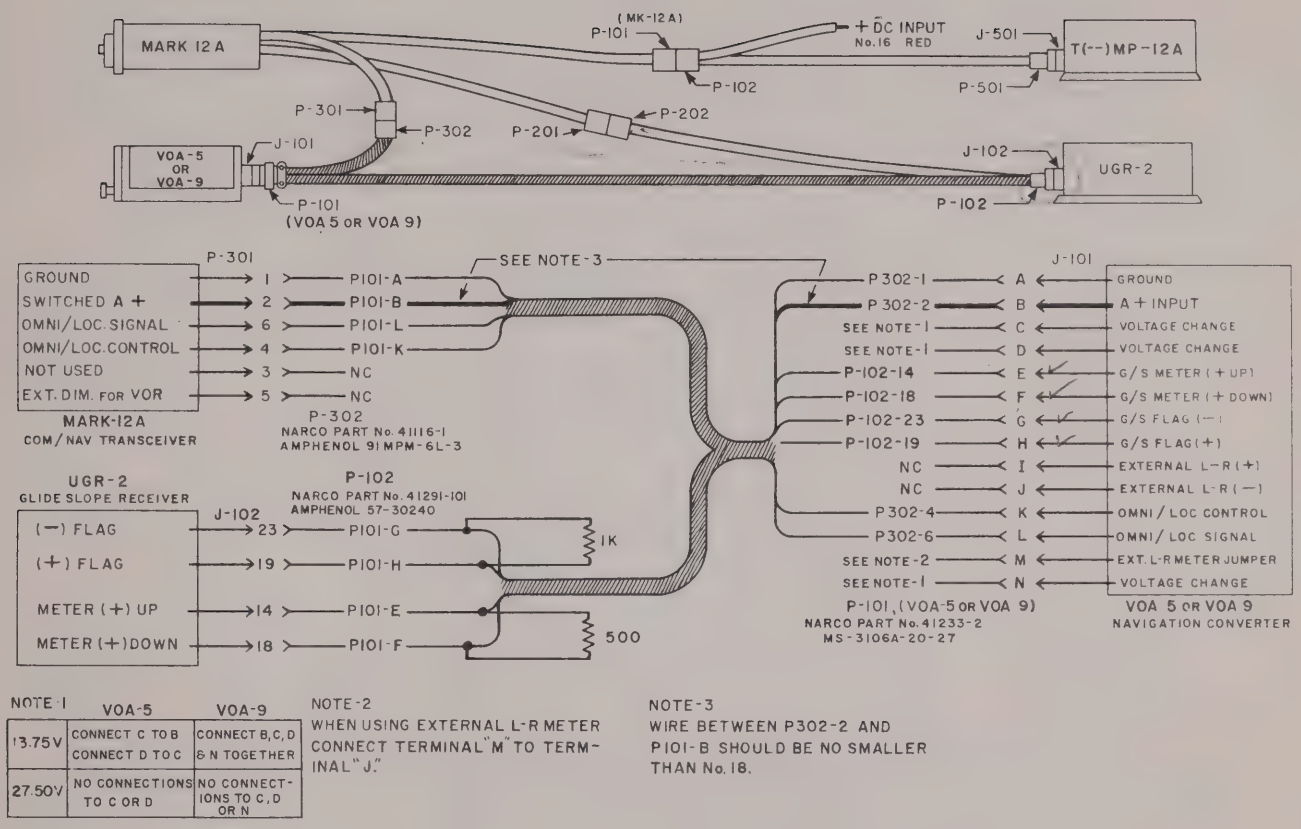


Figure 23.
INTERCONNECTIONS
narco VOA-5 CONVERTER and *narco* UGR-1A GLIDE
SLOPE RECEIVER.



NOTE-1

	VOA-5	VOA-9
13.75V	CONNECT C TO B CONNECT D TO C	CONNECT B, C, D & N TOGETHER
27.50V	NO CONNECTIONS TO C OR D	NO CONNECTIONS TO C, D OR N

NOTE-2
WHEN USING EXTERNAL L-R METER CONNECT TERMINAL "M" TO TERMINAL "J."

NOTE-3
WIRE BETWEEN P302-2 AND P101-B SHOULD BE NO SMALLER THAN No. 18.

Figure 24.
INTERCONNECTIONS.
narco Mark 12A COM/NAV EQUIPMENT with
narco VOA-5/9 NAV CONVERTER and ***narco*** UGR-2
SLOPE RECEIVER.

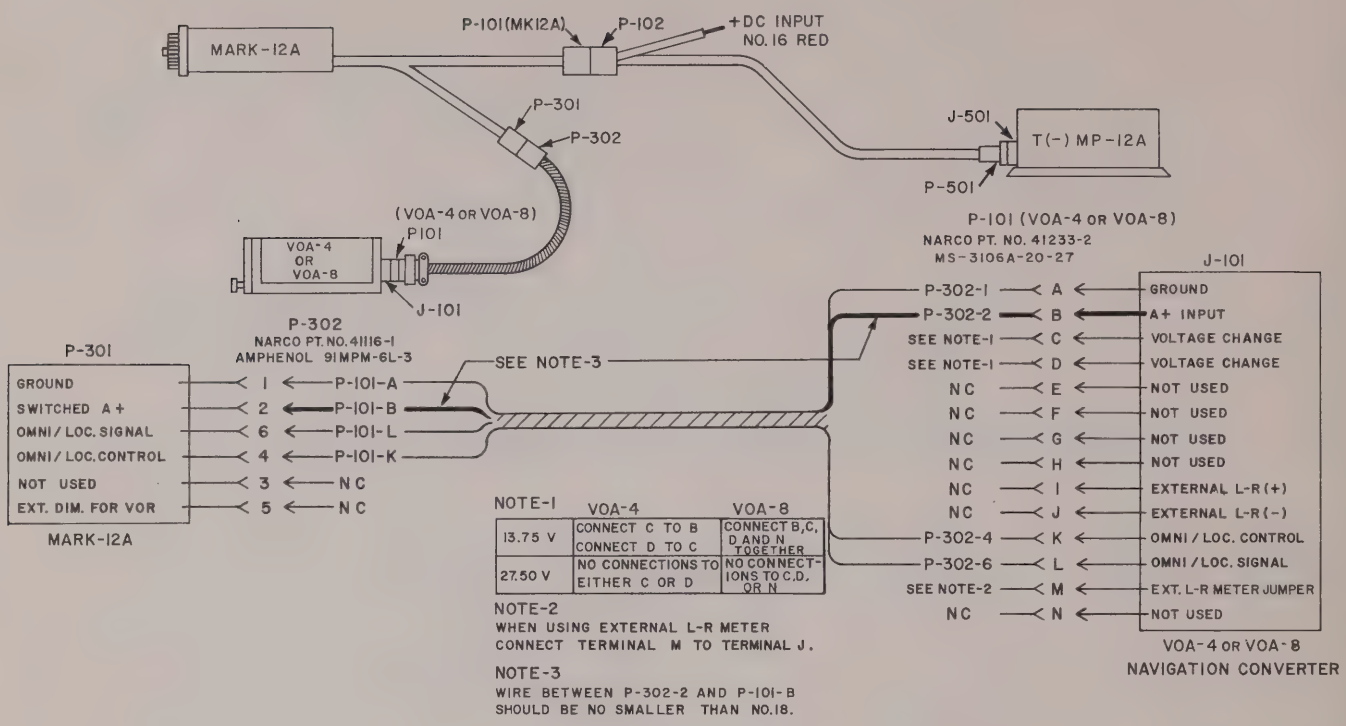


Figure 25.
INTERCONNECTIONS.
narco Mark 12A COM/NAV EQUIPMENT with
narco VOA-6 OMNI CONVERTER.

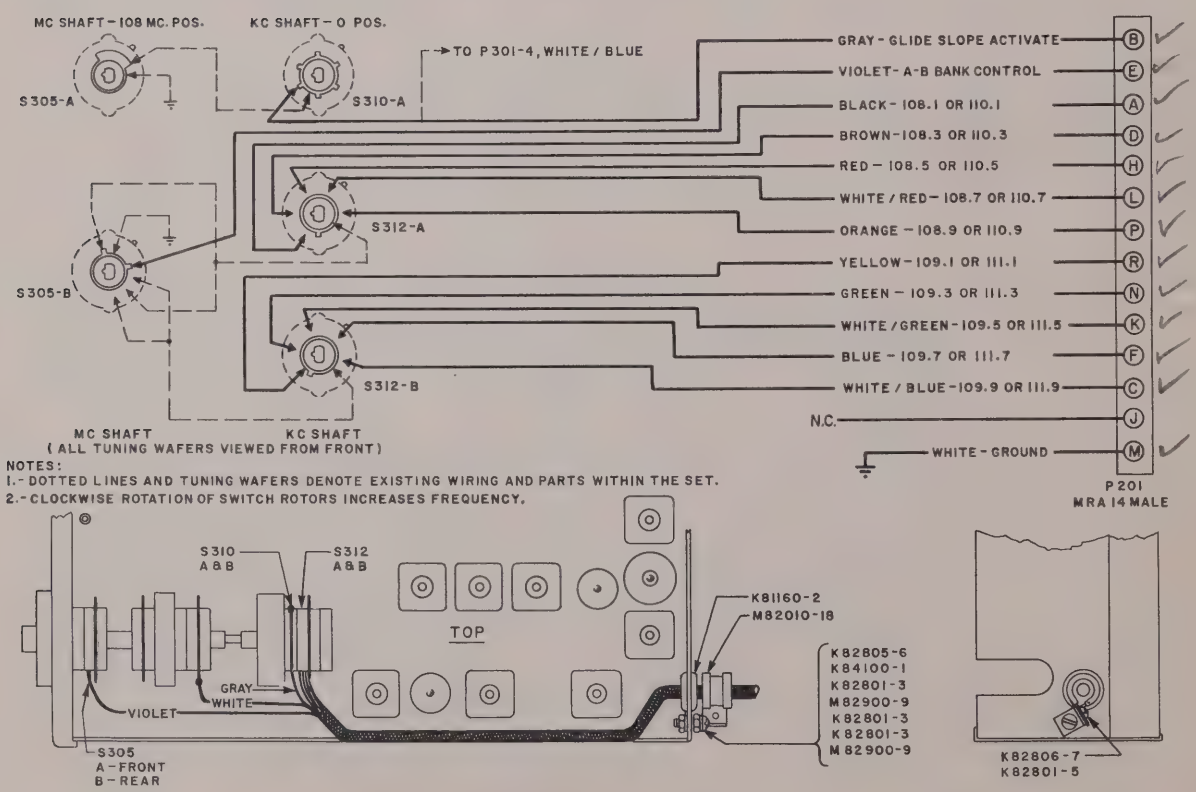
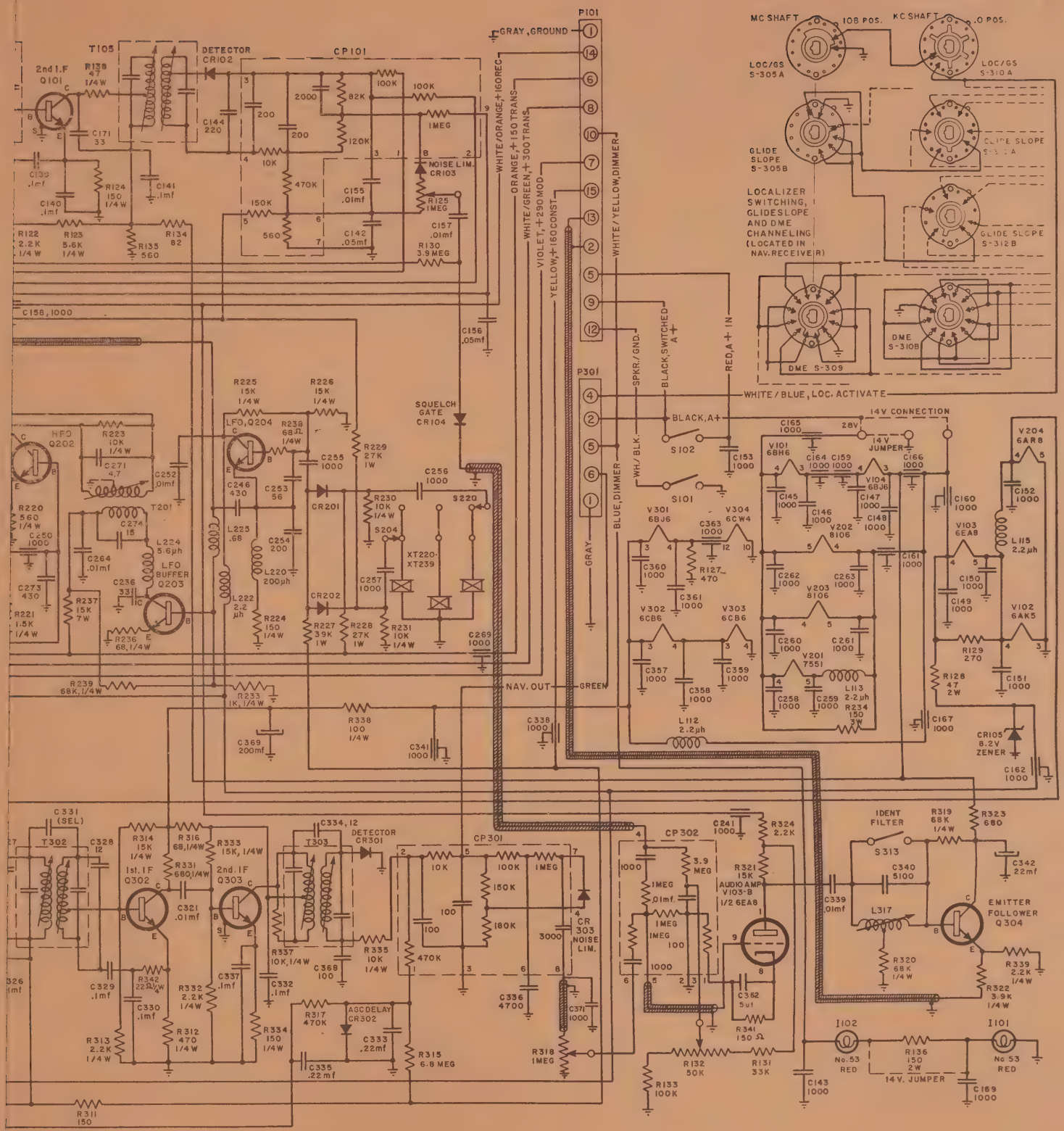


Figure 26.
SWITCH WIRING.
narco Mark 12A GLIDE SLOPE CHANNEL SELECTOR



*See Figure 29 for test points and service data.

FIGURE 34. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B3

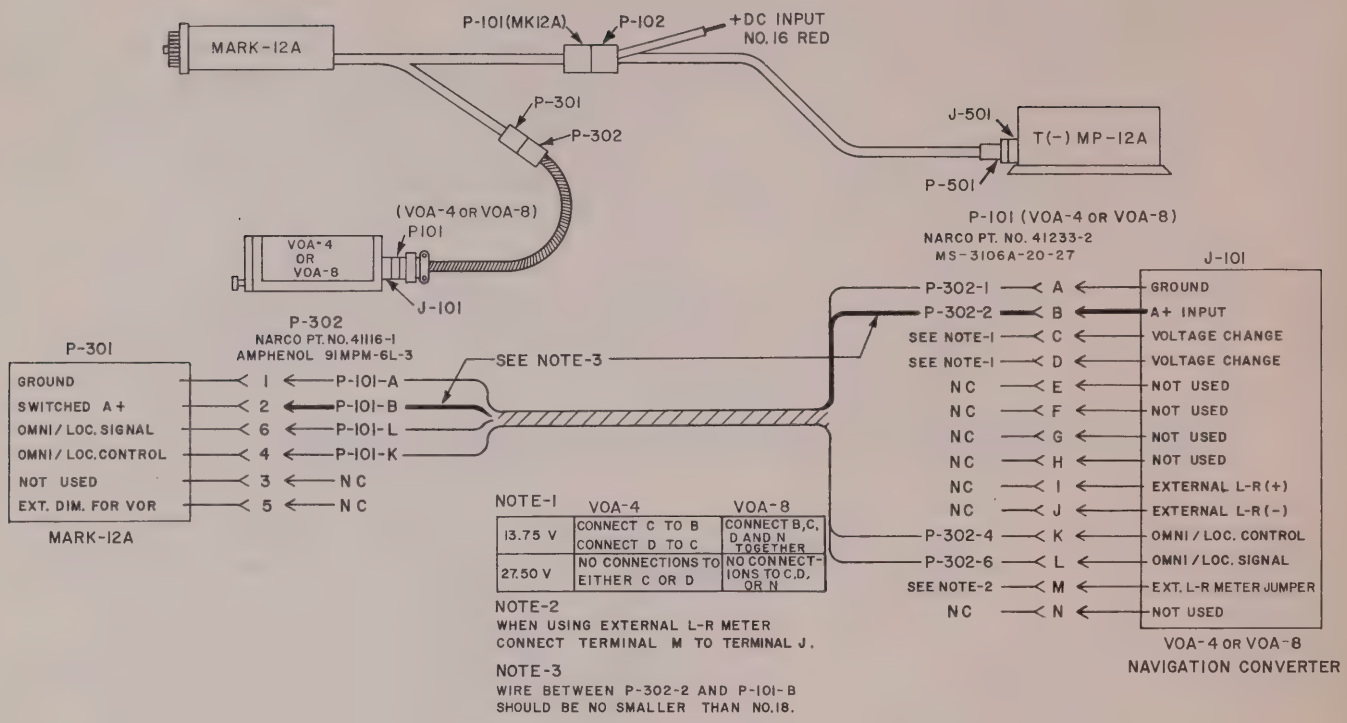


Figure 25.
INTERCONNECTIONS.
narco Mark 12A COM/NAV EQUIPMENT with
narco VOA-6 OMNI CONVERTER.

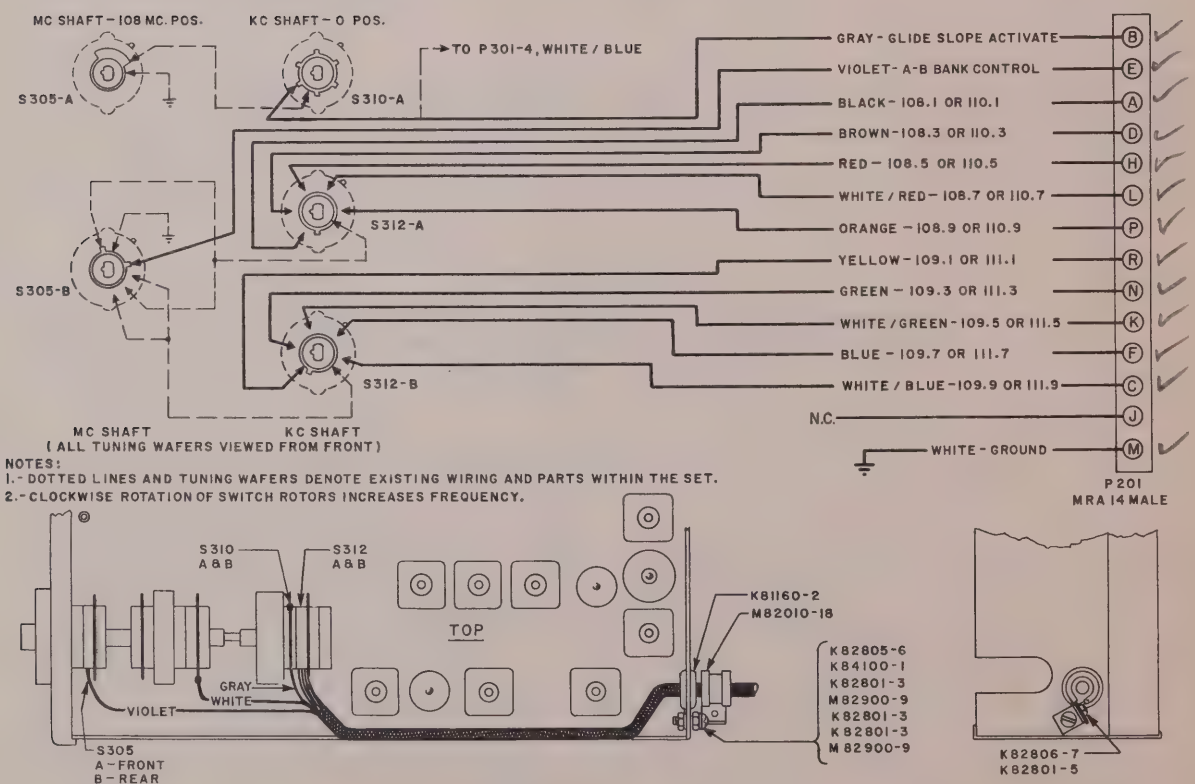
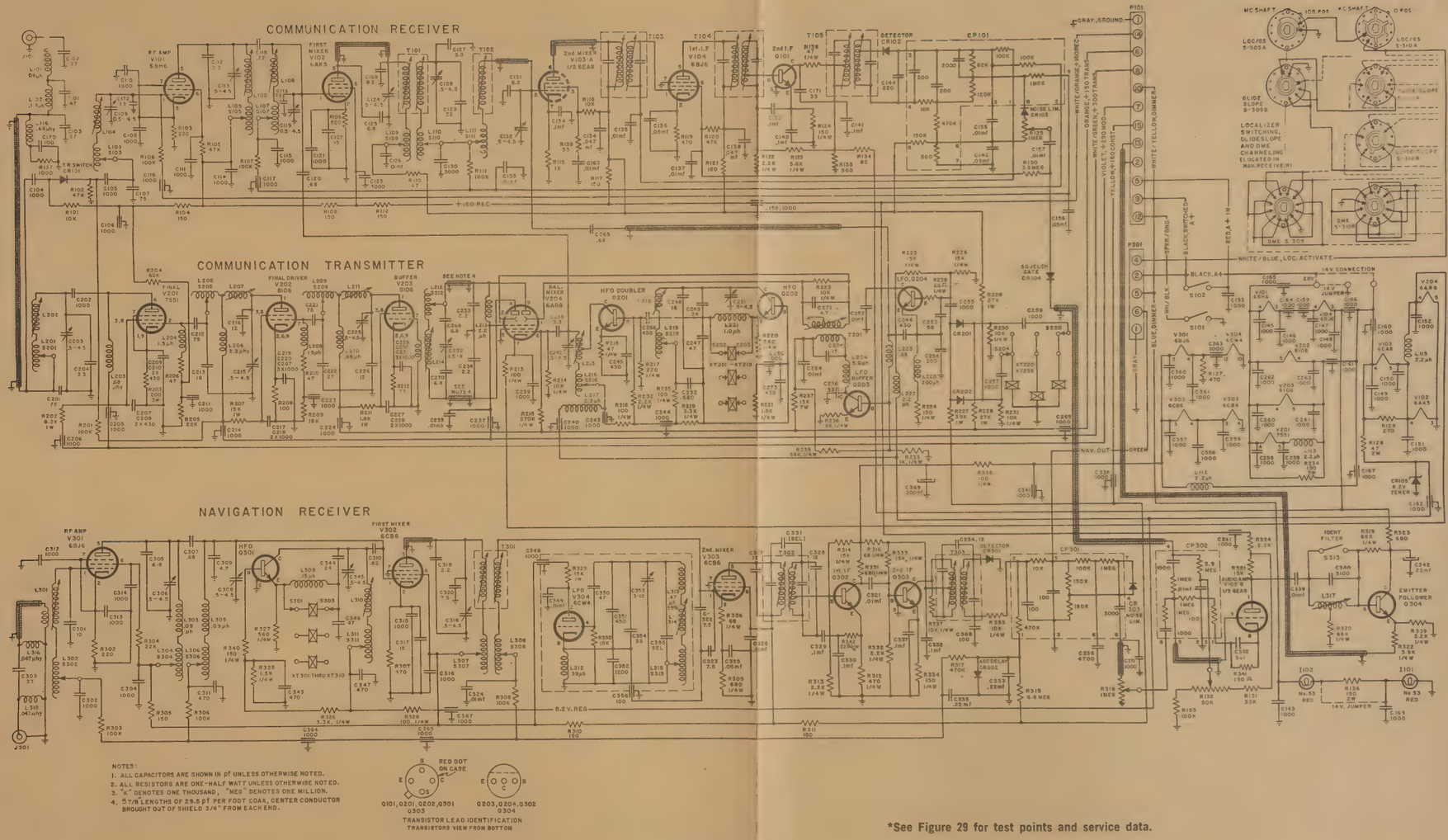


Figure 26.
SWITCH WIRING.
narco Mark 12A GLIDE SLOPE CHANNEL SELECTOR


COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 57/8' LENGTHS OF 29.5 pF PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
RED DOT ON CASE
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

*See Figure 29 for test points and service data.

FIGURE 34. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B3

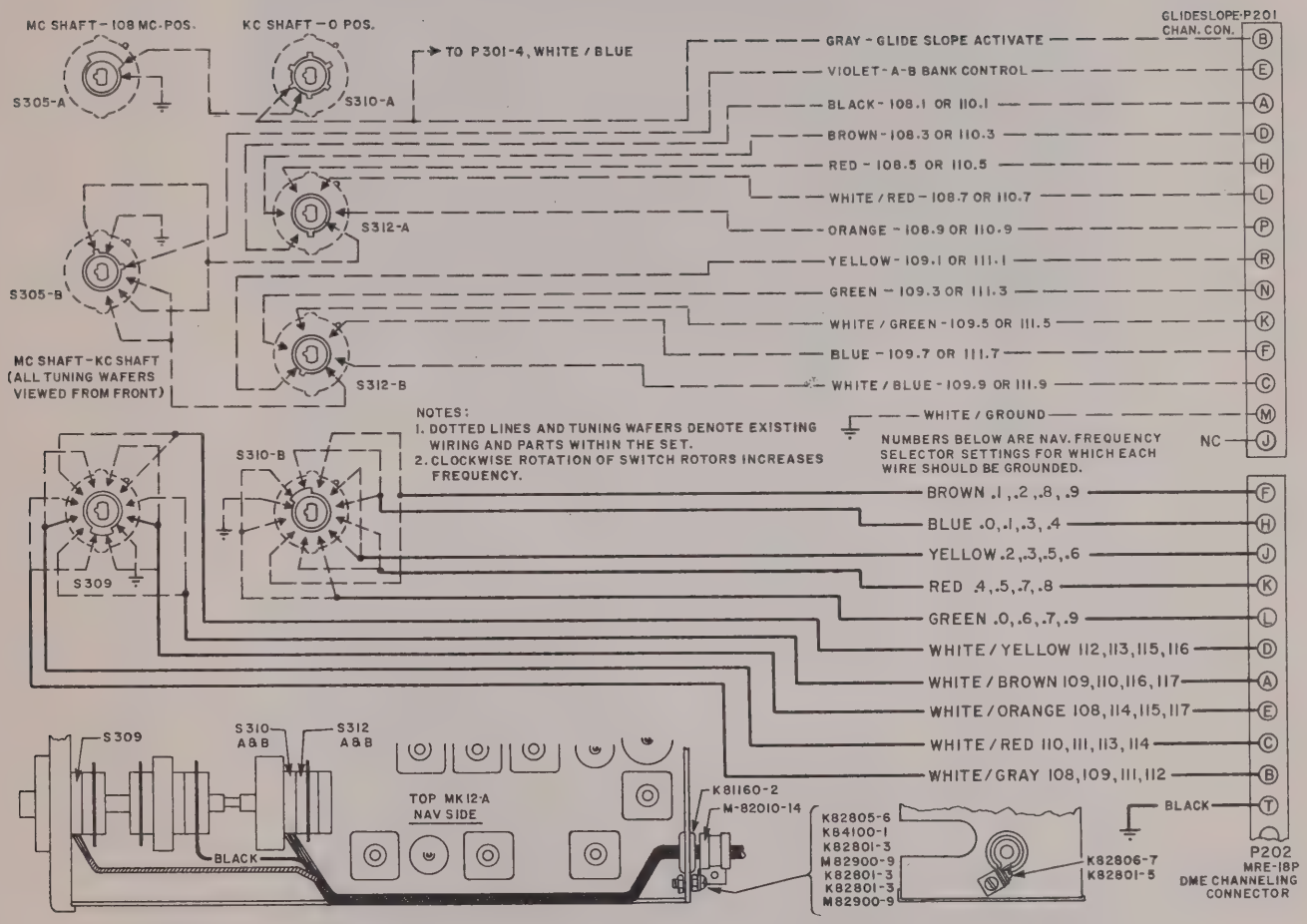

MC SHAFT – 108 MC-POS.
KC SHAFT – 0 POS.
S305-A
S310-A
TO P301-4, WHITE / BLUE
GLIDESLOPE P201 CHAN. CON.
GRAY - GLIDE SLOPE ACTIVATE
VIOLET - A-B BANK CONTROL
BLACK - 108.1 OR 110.1
BROWN - 108.3 OR 110.3
RED - 108.5 OR 110.5
WHITE / RED - 108.7 OR 110.7
ORANGE - 108.9 OR 110.9
YELLOW - 109.1 OR 111.1
GREEN - 109.3 OR 111.3
WHITE / GREEN - 109.5 OR 111.5
BLUE - 109.7 OR 111.7
WHITE / BLUE - 109.9 OR 111.9
WHITE / GROUND
NC
S312-A
S305-B
S312-B
MC SHAFT – KC SHAFT (ALL TUNING WAFERS VIEWED FROM FRONT)
NOTES:
1. DOTTED LINES AND TUNING WAFERS DENOTE EXISTING WIRING AND PARTS WITHIN THE SET.
2. CLOCKWISE ROTATION OF SWITCH ROTORS INCREASES FREQUENCY.
NUMBERS BELOW ARE NAV. FREQUENCY SELECTOR SETTINGS FOR WHICH EACH WIRE SHOULD BE GROUNDED.
S310-B
S309
BROWN .1, .2, .8, .9
BLUE .0, .1, .3, .4
YELLOW .2, .3, .5, .6
RED .4, .5, .7, .8
GREEN .0, .6, .7, .9
WHITE / YELLOW 112, 113, 115, 116
WHITE / BROWN 109, 110, 116, 117
WHITE / ORANGE 108, 114, 115, 117
WHITE / RED 110, 111, 113, 114
WHITE / GRAY 108, 109, 111, 112
S309
S310 A&B
S312 A&B
TOP MK12-A NAV SIDE
BLACK
K81160-2
M-82010-14
K82805-6
K84100-1
K82801-3
M82900-9
K82801-3
K82801-3
M82900-9
K82806-7
K82801-5
BLACK
P202 MRE-18P DME CHANNELING CONNECTOR

Figure 27.
SWITCH WIRING.
narco Mark 12A DME CHANNEL SELECTOR.

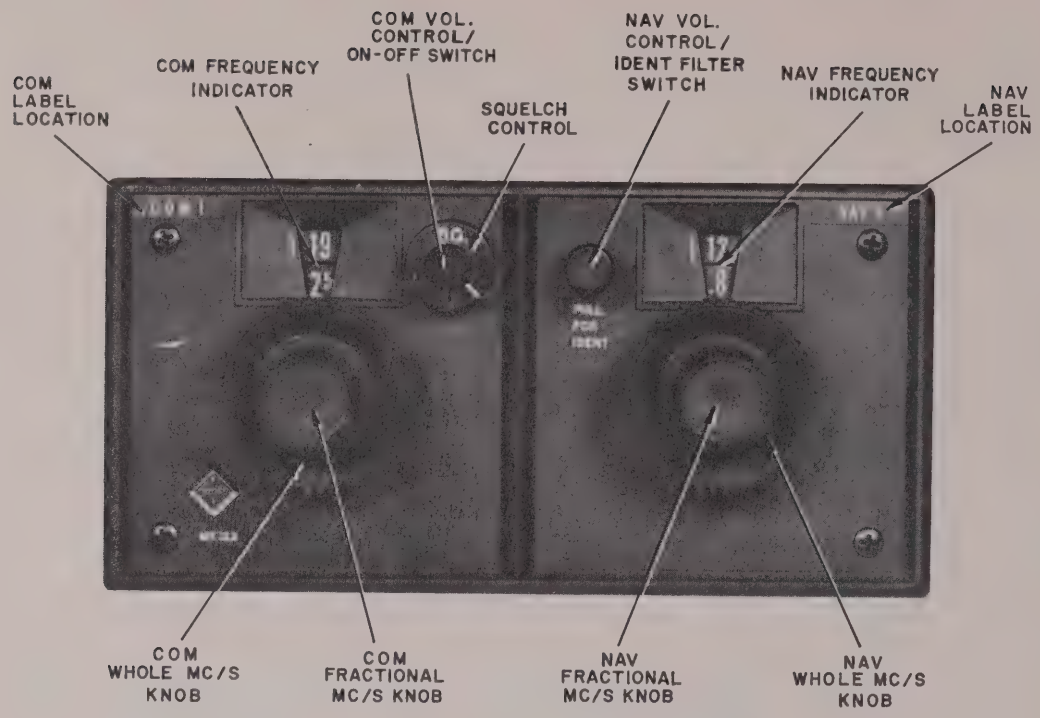


Photo A.
narco Mark 12A PANEL UNIT, Front View.

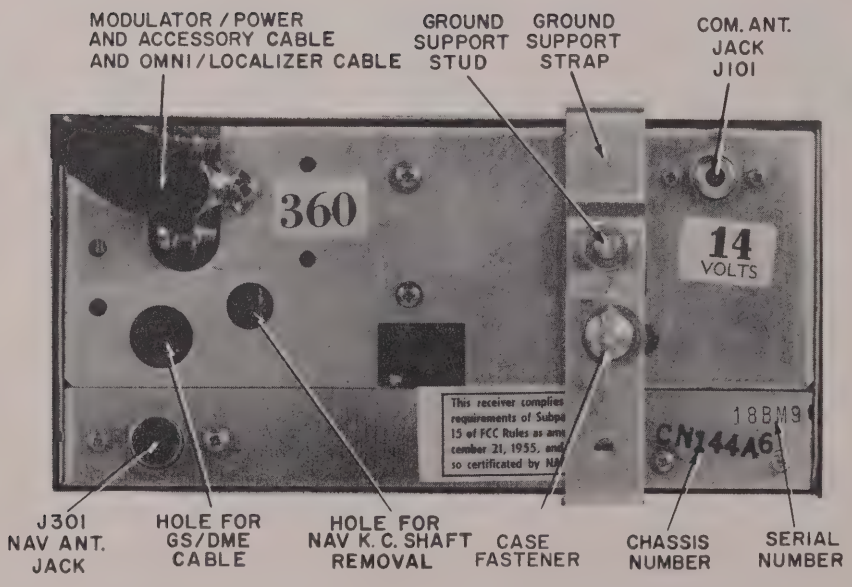


Photo B.
narco Mark 12A PANEL UNIT, Rear View, in Case.

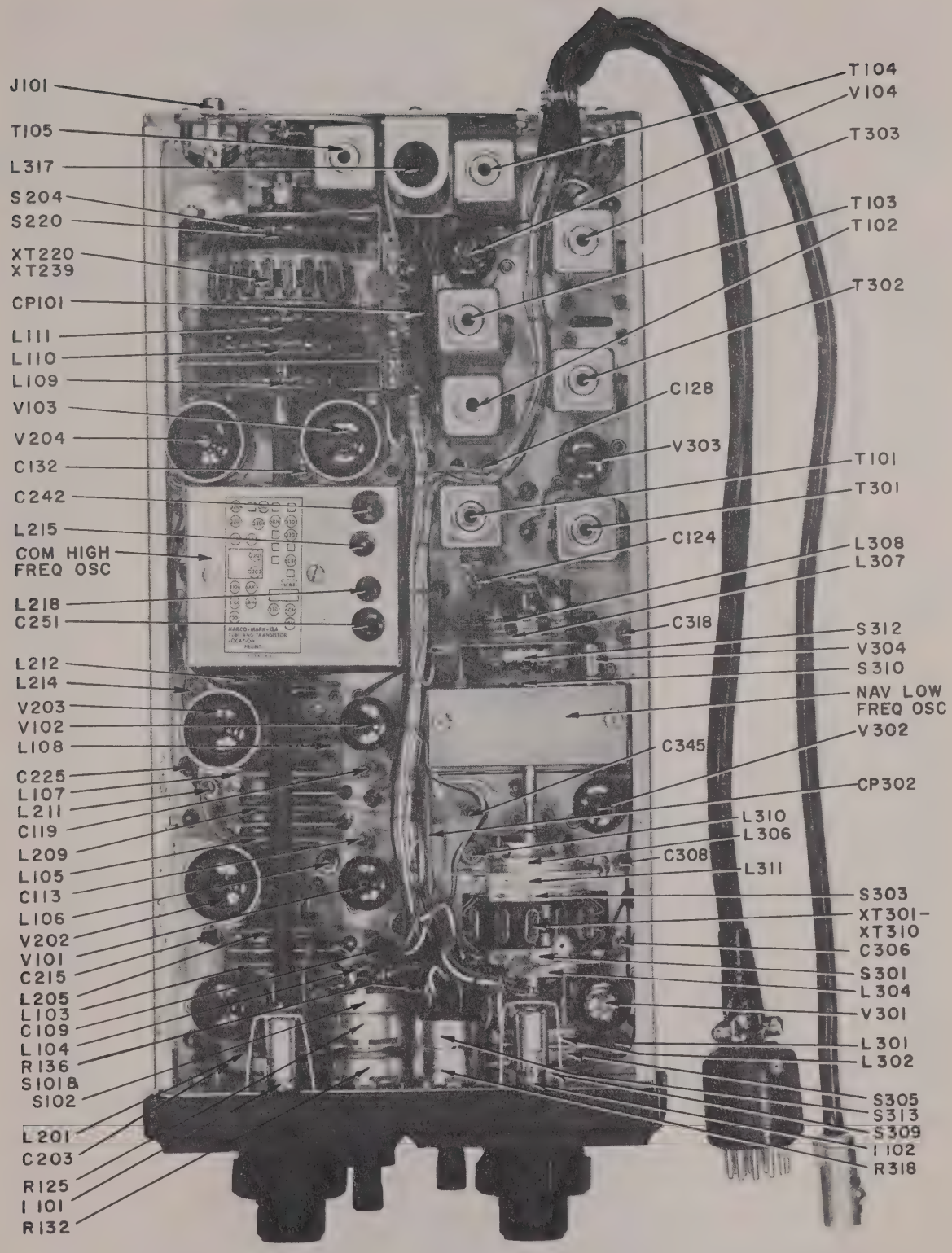


Photo C.
narco Mark 12A PANEL UNIT, Top View.

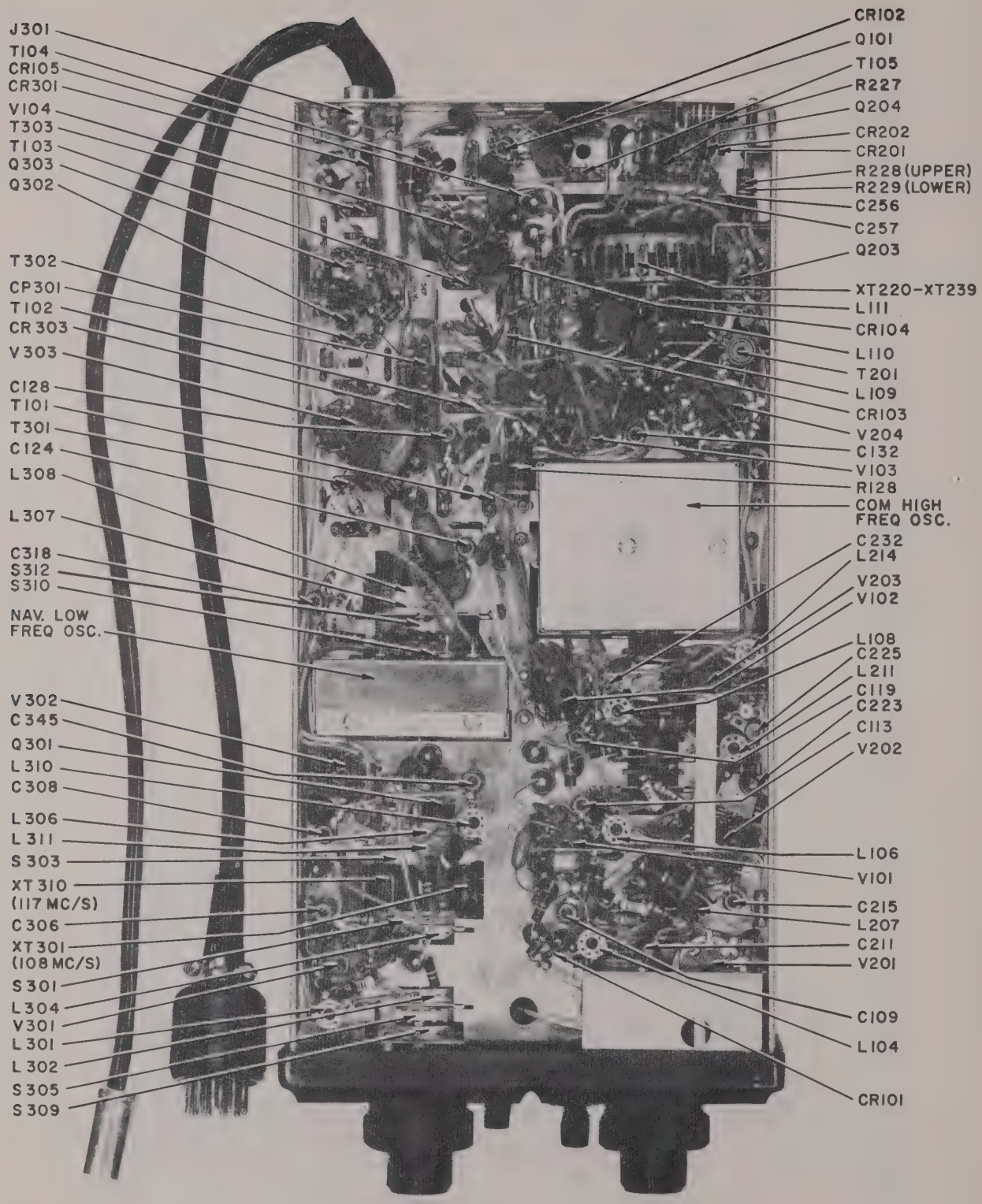


Photo D.
narco Mark 12A PANEL UNIT, Bottom View.

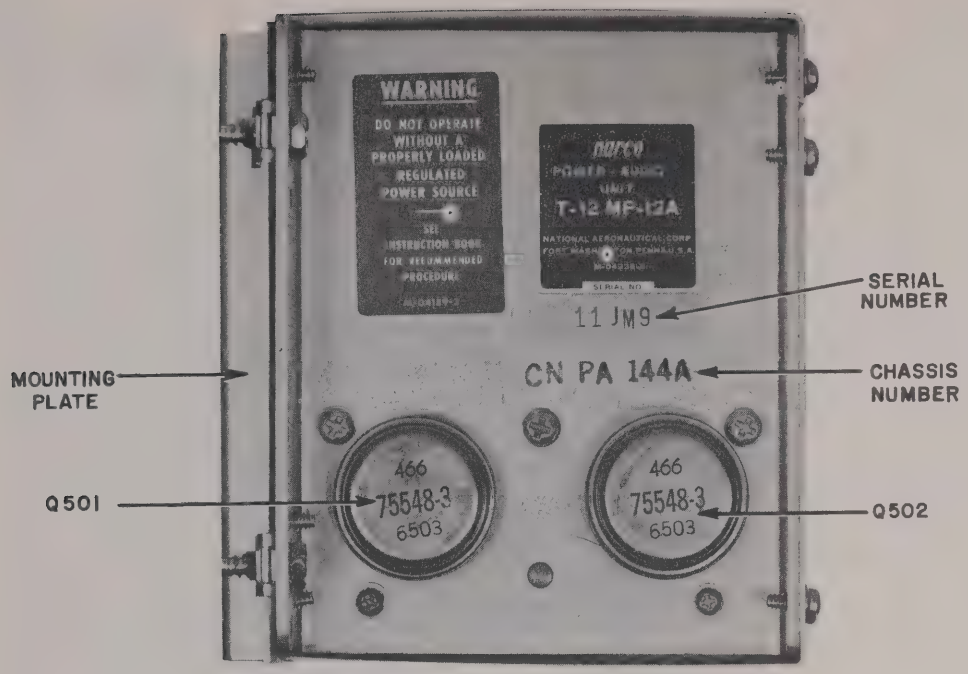


Photo E.
narco Mark 12A MODULATOR-POWER UNIT, Front View.

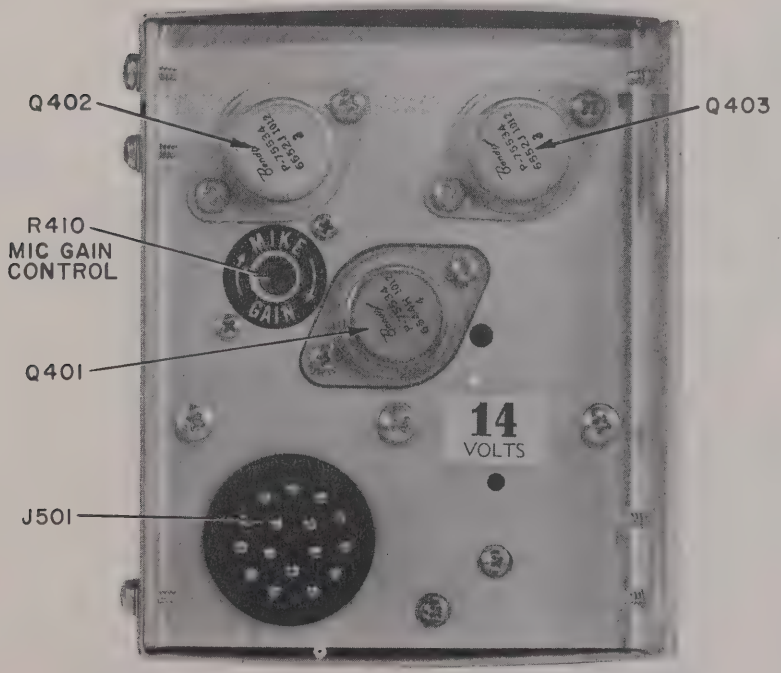
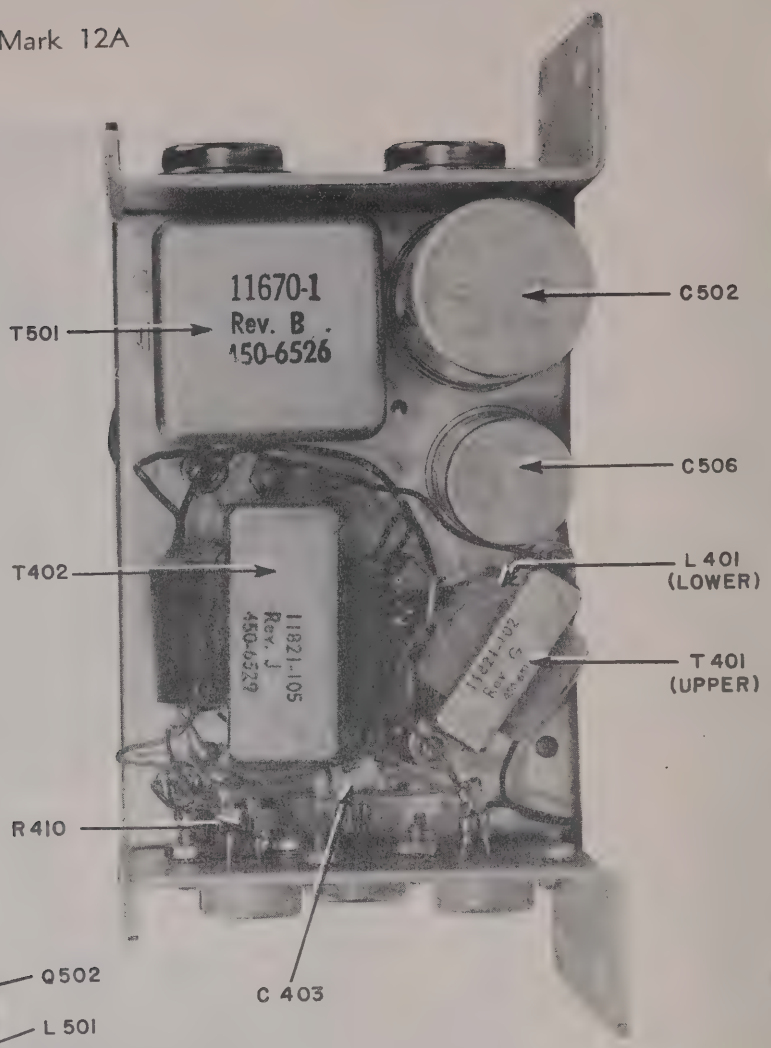


Photo F.
narco Mark 12A MODULATOR-POWER UNIT, Rear View.

Photo G.
narco Mark 12A
MODULATOR-POWER UNIT,
Top View.



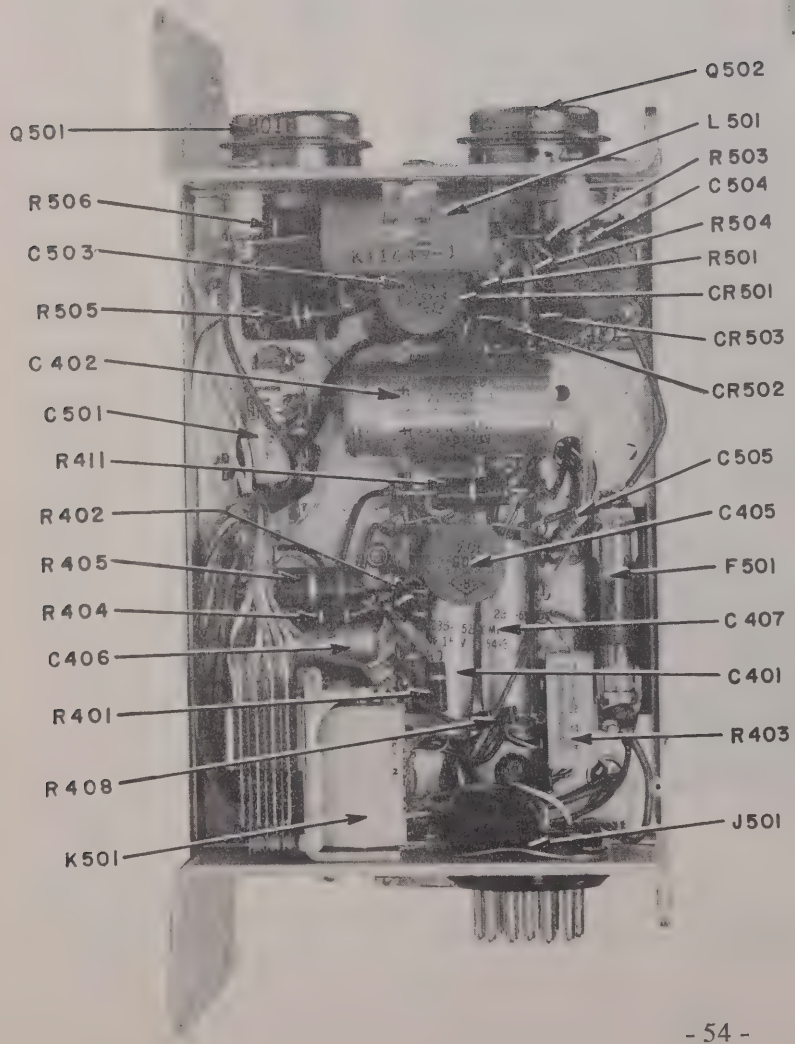


Photo H.
narco Mark 12A
MODULATOR-POWER UNIT,
Bottom View.

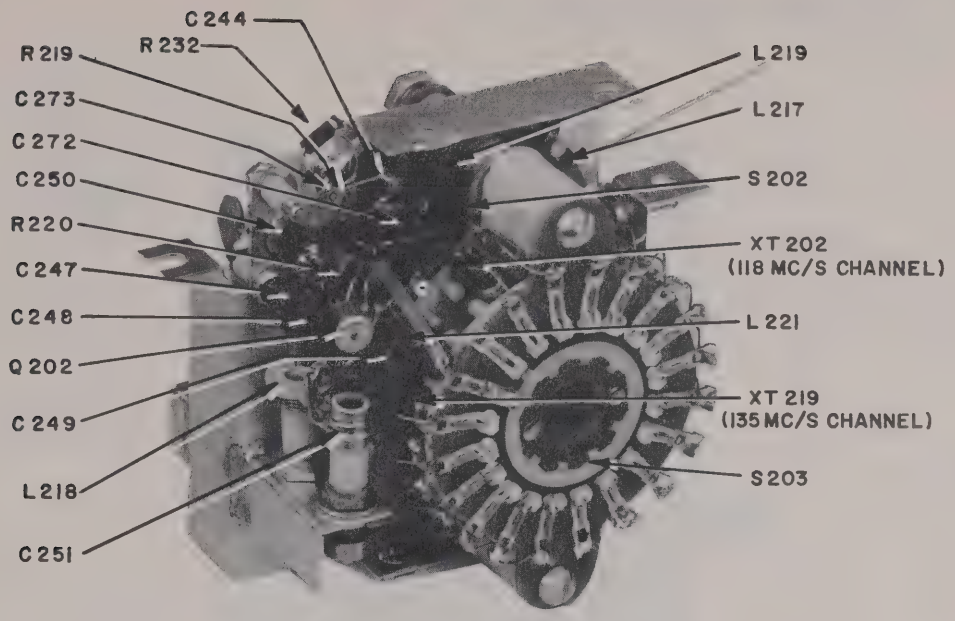


Photo I.
COM HFO SUB-ASSEMBLY, Front View.

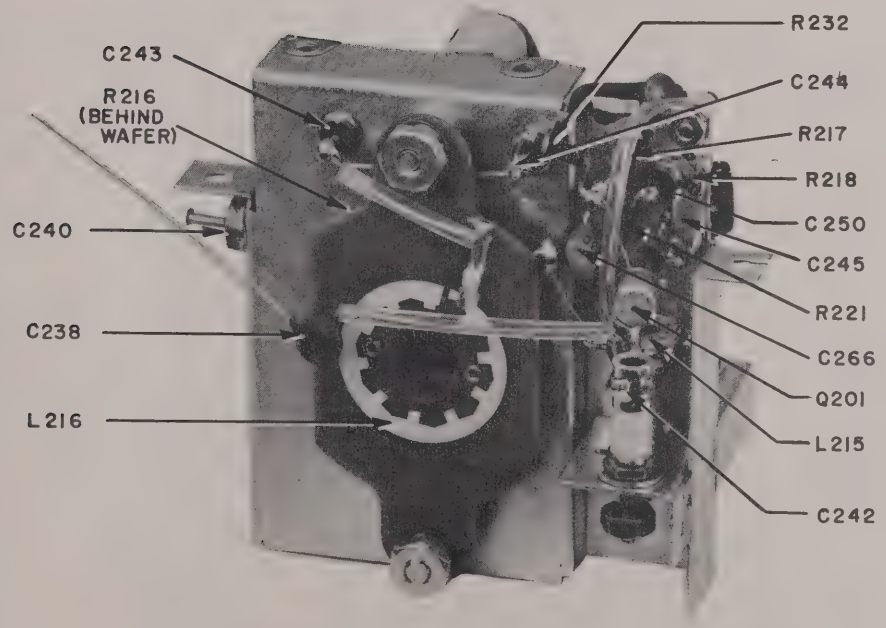


Photo J.
COM HFO SUB-ASSEMBLY, Rear View.

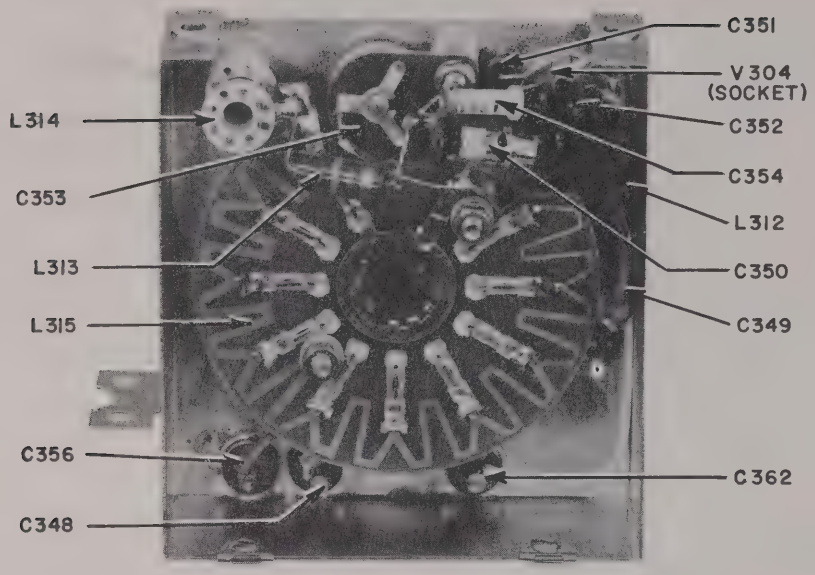


Photo K.
NAV LFO SUB-ASSEMBLY, Front View.

SECTION 7
REPLACEMENT PARTS

7-A. INTRODUCTION.

This list of Replacement Parts contains the items that may be considered replaceable in the field. They should preferably be ordered by Symbol No., Part No., and Description.

The Replacement Parts are listed by their Symbol letter and number, alphabetically then numerically. Some items without a Symbol No., are listed numerically by Part Number in a "Miscellaneous" List following the listings by Symbol numbers. A few items without a Symbol No. may be listed with associated parts such as connectors.

The "Function or Application" column is intended to separate the description of the item from its purpose in the equipment. It may also be found useful when working with the illustrations and Schematics.

7-B. LIST OF PARTS.

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-101	21201-470	Cap., Cer. Tub. 47 pf, ±10%, NPO, 500V	
C-102	21201-270	Cap., Cer. Tub. 27 pf, ±10%, NPO, 500V	
C-103	21201-270	Cap., Cer. Tub. 27 pf, ±10%, NPO, 500V	
C-104	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-105	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-106	21298-1	Cap., Feed Thru 1000 pf, +100%, —0%	
C-107	21384-750	Cap., Cer. Tub. 75 pf, ±5% N-750, 500V	
C-108	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-109	22019-2	Cap., Var. Plunger 1.5-12.5 pf	Com. Rcvr.
C-110	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-111	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-112	24516-229	Cap., Cer. Disc. 2.2 pf, ±.25 pf, 500V	
C-113	22019-1	Cap., Variable Plunger .5-4.5 pf	Com. Rcvr.
C-114	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-115	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-116	21298-1	Cap., Feed Thru 1000 pf, +100%, —0%	
C-117	21298-1	Cap., Feed Thru 1000 pf, +100%, —0%	Com. Rcvr.
C-118	24509-228	Cap., Cer. .22 pf, ±5%, 500V	
C-119	22019-2	Cap., Var. Plunger 1.5-12.5 pf	Com. Rcvr.
C-120	24502-688	Cap., Ceramic .68 pf, ±5%, 500V	
C-121	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-122	24516-150	Cap., Cer. Disc. 15 pf, ±10%, 500V	
C-123	21291-4	Cap., Cer. Disc., 3000 pf, +80%, —20%, 500V	
C-124	22019-1	Cap., Variable Plunger .5-4.5 pf	Com. Rcvr.
C-125	24516-689	Cap., Cer. Disc., 6.8 pf, ±0.5 pf, 500V	
C-126	21291-6	Cap., Cer. Disc., .01 μf, +80%, —30%, 500V	
C-127	24516-339	Cap., Cer. Disc., 3.3 pf, ±10%, 500V	
C-128	22019-1	Cap., Variable Plunger .5-4.5 pf	Com Rcvr.
C-129	21201-220	Cap., Cer. Tub., 22 pf, ±10%, NPO, 500V	
C-130	21291-9	Cap., Cer. Disc., 3000 pf, ±10%, 500V	
C-131	24516-829	Cap., Cer. Disc., 8.2 pf, ±0.5%, 500V	
C-132	22019-1	Cap., Variable Plunger .5-4.5 pf	Com. Rcvr.
C-133	21291-5	Cap., Ceramic, .01 mf, +80%, —20%, 50V	
C-134	23085-171	Cap., Mylar, .047 μf, ±10%, 20V	
C-135	21291-5	Cap., Ceramic, .01 μf, +80%, —20%, 50V	
C-136	24515-7	Cap., Ceramic, .05 μf, +80%, —20%, 20V	
C-137	21291-6	Cap., Ceramic Disc., .01 μf, +80%, —20%, 500V	
C-138	23085-171	Cap., Mylar, .047 μf, ±10%, 200V	
C-139	24515-1	Cap., Cer. Disc., .1 mf, +80%, —20%, 10V	
C-140	24515-1	Cap., Cer. Disc., .1 mf, +80%, —20%, 10V	
C-141	24515-6	Cap., Cer. Disc., .1 mf, +80%, —20%, 20V	
C-142	24515-7	Cap., Ceramic, .05 μf, +80%, —20%, 20V	
C-143	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-144	24049-221	Cap., Dipped Mica, 220 pf, ±5%, 500V	
C-145	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	

C, CAPACITORS

SYMBOL	NARO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
C-146	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-147	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-148	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-149	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-150	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-151	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-152	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-153	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-154	24515-1	Cap., Cer. Disc., .1 μf, +80%, —20%, 10V	
C-155	24515-9	Cap., Cer. Disc., .01 mf, +80%, —20%, 50V	
C-156	24515-7	Cap., Cer. Disc.,. 05 mf, +80%, —20%, 20V	
C-157	21291-6	Cap., Cer. Disc., .01 mf, +80%, —20%, 500V	
C-158	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-159	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-160	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-161	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-162	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-163	21291-6	Cap., Cer. Disc., .01 mf, +80%, —20%, 500V	
C-164	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-165	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-166	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-167	21298-1	Cap., Feedthru, 1000 pf, +100%, —0%	
C-168	24516-829	Cap., Cer. Disc., 8.2 pf, ±0.5 pf, 500V	
C-169	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-170	24049-101	Cap., Dipped Mica, 100 pf, ±5%, 500V	
C-171	24049-330	Cap. Dipped Mica, 33 pf, ±5%	
C-201	21384-750	Cap., Cer. Tub., 75 pf, ±5%, N-750, 500V	
C-202	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-203	22019-1	Cap., Variable Plunger, .5-4.5 pf	Com. Trans.
C-204	24516-339	Cap., Cer. Disc., 3.3 pf, ±.25 pf, 500V	
C-205	21298-1	Cap., Feed Thru 1000 pf, +100%, —0%	
C-206	21298-1	Cap., Feed Thru 1000 pf, +100%, —0%	
C-207	21291-1	Cap., Cer. Disc., 430 pf, ±20%, 500V	
C-208	21291-1	Cap., Cer. Disc., 430 pf, ±20%, 500V	
C-209	21291-1	Cap., Cer. Disc., 430 pf, ±20%, 500V	
C-210	21291-1	Cap., Cer. Disc., 430 pf, ±20%, 500V	
C-211	21298-1	Cap., Feed Thru 1000 pf, +100%, —0%	Com. Trans.
C-212	21384-750	Cap., Cer. Tub., 75 pf, ±5%, N-470, 500V	
C-213	21201-180	Cap., Cer. Tub., 18 pf, ±10%, NPO, 500V	
C-214	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	
C-215	22019-1	Cap., Variable Plunger, .5-4.5 pf	Com. Trans.
C-216	21201-120	Cap., Cer. Tub., 10 pf, ±10%, NPO, 500V	
C-217	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-218	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-219	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-220	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-221	21384-750	Cap., Cer. Tub., 75 pf, ±5%, N-470, 500V	
C-222	21201-270	Cap., Cer. Tub., 27 pf, ±10%, 500V, NPO	
C-223	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	
C-224	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	
C-225	22019-1	Cap., Variable Plunger, .5-4.5 pf	Com. Trans.
C-226	21201-120	Cap., Cer. Tub., 12 pf, ±10%, NPO, 500V	
C-227	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-228	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-229	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-230	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-231	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-232	22045-1	Cap., Var. Cer., 1.5-8 pf, NPO	
C-233	24516-229	Cap., Cer. Disc., 2.2 pf, ±.25 pf, 500V	Com. Trans.
C-234	24516-229	Cap., Cer. Disc., 2.2 pf, ±.25 pf, 500V	
C-235	21291-6	Cap., Cer. Disc., .01 μf, 500V GMV	
C-236	24049-330	Cap., Dipped Mica, 33 pf, ±5% 500V	
C-237	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	
C-238	24516-339	Cap., Cer. Disc., 3.3 pf, ±0.25 pf, 500V	Com. HFO
C-239	21291-21	Cap., Cer. Disc. 1000 pf, ±20%, 1KV	
C-240	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	Com. HFO

SYMBOL	NARO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-241	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	
C-242	22019-1	Cap., Variable Plunger, .5-4.5 pf	Com. HFO
C-243	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	Com. HFO
C-244	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	Com. HFO
C-245	21291-1	Cap., Cer. Disc., 430 pf, ±20%, 1KV	
C-246	21291-1	Cap., Cer. Disc., 430 pf, ±20%, 1KV	
C-247	24049-470	Cap., Dipped Mica, 47 pf, ±5%, 500V	Com. HFO
C-248	24049-180	Cap., Dipped Mica, 18 pf, ±5%, 500V	Com. HFO
C-249	24049-240	Cap., Dipped Mica, 24 pf, ±5%, 500V	Com. HFO
C-250	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	Com. HFO
C-251	22019-15	Cap., Variable Plunger, .5-4.5 pf	
C-252	24515-9	Cap., Cer. Disc., .01 μf, +80%, —20%, 50V	
C-253	24049-560	Cap., Dipped Mica, 56 pf, ±5%, 500V	
C-254	24049-201	Cap., Cer. Disc., 200 pf, ±10%, 300V	
C-255	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-256	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-257	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-258	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-259	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-260	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-261	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-262	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-263	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-264	24515-9	Cap., Cer. Disc., .01 μf, +80%, —20%, 50V	
C-265	24502-688	Cap., Ceramic, .68 pf, ±5%, 500V	
C-266	21291-1	Cap., Cer. Disc., 430 pf, ±20%, 500V	Comm. HFO
C-267	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-268	24516-689	Cap., Cer. Disc., 6.8 pf, ±0.5 pf, 500V	
C-269	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	
C-270	24516-689	Cap., Cer. Disc., 6.8 pf, ±0.5 pf, 500V	
C-271	24516-479	Cap., Cer. Disc., 4.7 pf, ±0.5 pf, 500V	
C-272	24045-681	Cap., Dipped Mica, 680 pf, ±5%, 500V	Comm. HFO
C-273	21291-1	Cap. Cer. Disc., 430 pf, ±20%, 500V	Comm. HFO
C-274	21201-150	Cap., Tub., Cer. 15 pf, ±10%, NPO	
C-301	21201-100	Cap., 10 pf, ±1.0 pf, NPO, 500V	
C-302	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-303	21201-270	Cap., Cer. Tub., 27 pf, ±100%, 500V	
C-304	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-305	24516-689	Cap., Cer. Disc., 6.8 pf, ±.5 pf, 500V	
C-306	22019-1	Cap., Variable Plunger, .5-4.5 pf	Nav. Rcvr.
C-307	24509-688	Cap., Cer., .68 pf, ±5%, 500V	
C-308	22019-1	Cap., Variable Plunger, .5-4.5 pf	Nav. Rcvr.
C-309	24516-479	Cap., Cer. Disc., 4.7 pf, ±0.5 pf, 500V	
C-310	24509-828	Cap., Cer., .82 pf, ±5%, 500V	Nav. Rcvr.
C-311	21291-2	Cap., Cer. Disc., 470 pf, ±10%, 500V	
C-312	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-313	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-314	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-315	21291-4	Cap., Cer. Disc., 3000 pf, +80%, —20%, 500V	
C-316	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-317	24516-150	Cap., Cer. Disc., 15 pf, ±10%, 500V	
C-318	22019-1	Cap., Variable Plunger, .5-4.5 pf	Nav. Rcvr.
C-319	21201-229	Cap., Cer. Tub., 2.2 pf, ±.25, 500V	
C-320	21282-2	Cap., Cer. Tub., 7.5 pf, ±0.5%, 500V, P-100	
C-321	24515-9	Cap., Cer. Disc., .01 μf, +80%, —20%, 50V	
C-322	21201-759	Cap., Cer. Tub., 7.5 pf, NPO	
C-323	21282-2	Cap., Cer. Tub., 7.5 pf, ±0.5%, 500V, P-100	
C-324	21291-6	Cap., Disc., Cer. .01 μf, GMV, 500V	
C-325	24515-7	Cap., Ceramic, .05 μf, +80%, —20%, 20V	
C-326	21291-6	Cap., Cer. Disc., .01 μf, +80%, —20%, 500V	
C-327	21207-120	Cap., Cer. Tub., 12 pf, N-750	
C-328	21207-120	Cap., Cer. Tub., 12 pf, N-750	
C-329	24515-1	Cap., Cer. Disc., .1 μf, +80%, —20%, 10V	
C-330	24515-1	Cap., Cer. Disc., .1 μf, +80%, —20%, 10V	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		C, CAPACITORS	
C-331	24509	Cap., Cer., Selected	
C-332	24515-6	Cap., Cer. Disc., .1 μf, +80%, —20%, 20V	
C-333	23091-79	Cap., Ceramic, .22 μf, ±10%, 75V	
C-334	21207-120	Cap., Cer. Tub., 12 pf, M-750	
C-335	23091-79	Cap., Cer., .22 μf, ±10%, 75V	
C-336	23085-9	Cap., Mylar, 4700 pf, ±20%, 100V	
C-337	24515-1	Cap., Cer. Disc., .1 μf, +80%, —20%, 10V	
C-338	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	Nav. Rcvr.
C-339	21291-6	Cap., Cer. Disc., .01 μf, +80%, —20%, 500V	
C-340	24045-512	Cap., Dipped Mica, 5100 pf, ±5%, 300V	
C-341	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	
C-342	21555-18	Cap., Solid Tantalum, 22/15	
C-343	21291-2	Cap., Cer. Disc., 470 pf, ±20%, 500V	
C-344	24049-240	Cap., Dipped Mica, 24 pf, ±5%, 500V	
C-345	22019-1	Cap., Variable Plunger, .5-4.5 pf	Nav. Rcvr.
C-346	24049-470	Cap., Dipped Mica, 47 pf, ±5%, 500V	
C-347	21291-2	Cap., Cer. Disc., 470 pf, ±20%, 500V	
C-348	21298-1	Cap., Feed Thru, 1000 pf, +100%, —0%	Nav. LFO
C-349	21291-6	Cap., Cer. Disc., .01 μf, 500V, GMV	Nav. LFO
C-350	21299-470	Cap., Cer. Tub., 47 pf, NPO, 500V	Nav. LFO
C-351	24049-431	Cap., Dipped Mica, 430 pf, ±5%	Nav. LFO
C-352	24045-122	Cap., Dipped Mica, 1200 pf, ±5%	Nav. LFO
C-353	22001-312	Cap., Variable, 3-12 pf, NPO	Nav. LFO
C-354	21294-330	Cap., Cer. Tub., 33 pf, N-1500	
C-355	21201-470	Cap., Cer. Tub., Selected	
C-356	24517-1	Cap., Feed Thru, 100 pf.	Nav. Rcvr.
C-357	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-358	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-359	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-360	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-361	21291-21	Cap., Cer. Disc., 1000 pf, ±20%, 1KV	
C-362	21552-1	Cap., Electrolytic, 5.0μf, 10V	
C-363	21298-1	Cap., Feed Thru, 1000 pf, +80%, —20%	
C-364	21298-1	Cap., Feed Thru, 1000 pf, +80%, —20%	
C-365	21298-1	Cap., Feed Thru, 1000 pf, +80%, —20%	
C-366		Not Used	
C-367	21298-1	Cap., Feed Thru, 1000 pf, +80%, —20%	
C-368	24049-101	Cap., Dipped Mica, 100 pf, ±5%, 500V	
C-369	21554-3	Cap., Electrolytic, 200 μf, 15V	
C-370	24516-689	Cap., Cer. Disc., 6.8 pf, ±0.5 pf, 500V	
C-401	21554-3	Cap., Electrolytic 200/15	
C-402	21552-17	Cap., Electrolytic 500/15	
C-403	23085-113	Cap., Mylar, .01 ±20%, 200V	
C-404	21552-3	Cap., Electrolytic 20/35	
C-405	21291-22	Cap., Ceramic Disc., .005 mfd, ±10%, 500V	
C-406	21552-18	Cap., Electrolytic 30/15	
C-407	21554-3	Cap., Electrolytic 200/15	
C-501	23085-25	Cap., Mylar, .1 mfd, 20%, 100V	
C-502	21556-1	Cap., Electrolytic, 40/475, 20/250, 100/250	
C-503	21291-22	Cap., Ceramic Disc., .005 mfd, ±10%, 500V	Mod. Pwr. 14V
C-503	21291-23	Cap., Ceramic Disc., .004 mfd, ±10%, 500V	Mod. Pwr. 28V
C-504	21291-22	Cap., Ceramic Disc., .005 mfd, ±10%, 500V	Mod. Pwr. 14V
C-504	21291-23	Cap., Ceramic Disc., .004 mfd, ±10%, 500V	Mod. Pwr. 28V
C-505	21555-48	Cap., Solid Tant., 1.0 mfd, 35V	
C-506	21525-29	Cap., Electrolytic 500/35	
C-507	23085-25	Cap., Mylar, .1 mfd, 20%, 100V	
C-508	23085-25	Cap., Mylar, .1 mfd, 20%, 100V	
		CP, CIRCUIT PLATES	
CP-101	24525-1	Circuit Plate Comm. Detector	
CP-301	24524-1	Circuit Nav. Detector	
CP-302	24526-1	Circuit Plate Audio Combiner	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		CR, DIODES	
CR-101	75013-5	Diode, Silicon CD12227	
CR-102	75019-2	Diode, Silicon CD6487	
CR-103	75013-4	Diode, Silicon CD12226	
CR-104	75013-4	Diode, Silicon CD12226	
CR-105	75025-2	Diode-Zener 8.2V, ±10%, 1W	
CR-201	75021-2	Diode, Silicon	
CR-202	75021-2	Diode, Silicon	
CR-301	75019-2	Diode, Silicon CD6487	
CR-302	75013-4	Diode, Silicon CD 12226	
CR-303	75013-4	Diode, Silicon CD 12226	
CR-501	75204-45	Diode, Silicon 500 PIV	
CR-502	75204-45	Diode, Silicon 500 PIV	
CR-503	75204-45	Diode, Silicon 500 PIV	
CR-504	75204-45	Diode, Silicon 500 PIV	
CR-505	75204-45	Diode, Silicon 500 PIV	
CR-506	75204-45	Diode, Silicon 500 PIV	
		F, FUSES	
F-501	66504-12	Fuse 10A SLO/BLO	
F-501	66504-10	Fuse 6¼A SLO/BLO	
		I, LAMPS	
I-101		Lamp #53 Red	
I-102		Lamp #53 Red	
		J, JACKS (Connectors) See Also P, PLUGS	
J-101	41110-2	Connectors, Ant., Comm.	
J-301	41143-1	Connector, Ant., Nav.	
J-501	41181-4	Connector 16 Pin	
		K, RELAY	
K-501	65126-23	Relay	
		L, INDUCTORS	
L-101	11135-9	Choke, Antenna Filter .08 μhy	
L-102	11135-9	Choke, Antenna Filter .08 μhy	
L-103	61378-101	Step Inductor	
L-104	11273-26	Coil, Ant. Comm. Rec.	Com. Rcvr.
L-105	61378-101	Step Inductor	
L-106	11412-123	Coil, RF Plate, Comm.	Com. Rcvr.
L-107	61378-101	Step Inductor	
L-108	11412-129	Coil, Mixer, Comm.	Com. Rcvr.
L-109	61406-1	Step Inductor, HF, IF Comm.	
L-110	61406-1	Step Inductor, HF, IF Comm.	
L-111	61406-1	Step Inductor, HF, IF Comm.	
L-112	11138-9	Choke, Insulated, 2.2. μhy	
L-113	11138-9	Choke, Insulated, 2.2. μhy	
L-115	11138-9	Choke, Insulated, 2.2. μhy	
L-116	11138-6	Choke, Insulated, .68 μhy	
L-201	61378-101	Step Inductor	
L-202	11627-1	Coil, Final Tank	
L-203	11138-6	Choke, Insulated, .68 μhy	
L-204	11138-8	Choke, Insulated, 1.5 μhy	
L-205	61378-101	Step Inductor	
L-206	11138-9	Choke, Insulated, 2.2 μhy	
L-207	11495-1	Coil, Second Buffer	
L-208	11138-8	Choke, Insulated, 1.5 μhy	
L-209	61378-101	Step Inductor	
L-210	11138-6	Choke, Insulated, .68 μhy	
L-211	11412-134	Coil, First Buffer	
L-212	61378-101	Step Inductor	
L-213	11138-9	Choke, Insulated, 2.2 μhy	
L-214	11503-7	Coil, Mixer	
L-215	11503-5	Coil, Doubler	Com. HFO

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
L-216	61393-101	Step Inductor, Doubler	Com. HFO
L-217	11138-9	Choke, Insulated, 2.2 μhy	Com. HFO
L-218	11412-112	Coil, Comm. HFO	Com. HFO
L-219	61393-101	Step Inductor OSC.	Com. HFO
L-220	11451-46	Choke, Insulated, 200 μhy	
L-221	11138-7	Choke, Insulated, 1.0 μhy	
L-222	11138-9	Choke, Insulated, 2.2 μhy	
L-223		Not Used	
L-224	11138-14	Choke, Insulated, 5.6 μhy	
L-225	11138-6	Choke, Insulated, .68 μhy	
L-301	11273-22	Coil, Antenna	Nav. Rcvr.
L-302	61386-1	Step Inductor	
L-303	11138-27	Choke, Insulated, .09 μhy	
L-304	61386-1	Step Inductor	
L-305	11138-27	Choke, Insulated, .09 μhy	
L-306	61386-1	Step Inductor	
L-307	61407-1	Step Inductor, HF IF	
L-308	61407-1	Step Inductor, HF IF	
L-309	11138-2	Choke, Insulated, .15 μhy	
L-310	11503-6	Coil, Nav. HFO	NAV. Rcvr.
L-311	61386-1	Step Inductor	
L-312	11359-20	Choke, Insulated, 39 μhy	Nav. LFO
L-313	11138-5	Choke, Insulated, 0.47 μhy, ±20%	Nav. LFO
L-314	11273-21	Coil, LFO	Nav. LFO
L-315	61384-1	Step Inductor, LFO	Nav. LFO
L-316	11135-10	Choke, Antenna Filter	
L-317	11446-2	Inductor Adjustable Center Tapped	
L-318	11135-10	Choke, Antenna Filter	
L-401	11814-3	Inductor, Filter	
L-501	11449-1	Choke 50 μh	
		P, PLUGS (Connectors) See also J, JACKS	
P-101	41181-3	Connector, 16 Pin Male	
	41288-1	Cap., Plug	
P-301	41117-1	Connector, 6 Pin Female	
		Q, TRANSISTORS	
Q-101	75547-2	Transistor, Silicon NPN	
Q-201	75547-2	Transistor, Silicon NPN	
Q-202	75547-2	Transistor, Silicon NPN	
Q-203	75550-7	Transistor, NPN Silicon Planar 2N3391	
Q-204	75550-7	Transistor, Silicon NPN	
Q-301	75547-2	Transistor, NPN Silicon	
Q-302	75550-7	Transistor, NPN Silicon	
Q-303	75547-2	Transistor, NPN Silicon	
Q-304	75550-7	Transistor, NPN Silicon	
Q-401	75534-4	Transistor Driver	
Q-402	75534-3	Transistor Output	Mod. Pwr. 14V
Q-402	75511-3	Transistor Output	Mod. Pwr. 28V
Q-403	75534-3	Transistor Output	Mod. Pwr. 14V
Q-403	75511-3	Transistor Output	Mod. Pwr. 28V
Q-501	75548-3	Transistor Power 2N441	Mod. Pwr. 14V
Q-501	75505-3	Transistor Power 2N174	Mod. Pwr. 28V
Q-502	75548-3	Transistor Power 2N441	Mod. Pwr. 14V
Q-502	75505-3	Transistor Power 2N174	Mod. Pwr. 28V
		R, RESISTORS	
R-101	31141-103	Resistor, Carbon, 10K ohms, ±10%, ½W	
R-102	31141-473	Resistor, Carbon, 47K ohms, ±10%, ½W	
R-103	31141-221	Resistor, Carbon, 220 ohms, ±10%, ½W J	
R-104	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-105	31141-473	Resistor, Carbon, 47K ohms, ±10%, ½W	
R-106	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-107	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-108	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-109	31141-821	Resistor, Carbon, 820 ohms, ±10%, ½W	
R-110	31141-470	Resistor, Carbon, 47 ohms, ±10%, ½W	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
R-111	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-112	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-115	31141-102	Resistor, Carbon, 1K ohms, ±10%, ½W	
R-116	31141-103	Resistor, Carbon, 10K ohms, ±10%, ½W	
R-117	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-119	31141-471	Resistor, Carbon, 470 ohms, ±10%, ½W	
R-120	31141-473	Resistor, Carbon, 47K ohms, ±10%, ½W	
R-121	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-122	31192-222	Resistor, Carbon, 2.2K ohms, ±10%, ¼W	
R-123	31192-562	Resistor, Carbon, 5.6K ohms, ±10%, ¼W	
R-124	31192-151	Resistor, Carbon, 150 ohms, ±10%, ¼W	
R-125	32033-2	Pot., 1 Meg.ohms, Vol. Cont/Sw./Squelch	
R-127	31141-471	Resistor, Carbon, 470 ohms, ±10%, ½W	
R-128	31136-470	Resistor, Carbon, 47 ohms, ±10%, 2W	
R-129	31141-271	Resistor, Carbon, 270 ohms, ±10%, ½W	
R-130	31141-395	Resistor, Carbon, 3.9 Meg. ohms, 10%, ½W	
R-131	31141-333	Resistor, Carbon, 33K ohms, ±10%, ½W	
R-132		Pot., 50K ohms, Part of R-125	
R-133	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-134	31141-820	Resistor, Carbon, 820 ohms, ±10%, ½W	
R-135	31141-561	Resistor, Carbon, 560 ohms, ±10%, ½W	
R-136	31136-151	Resistor, Carbon, 150 ohms, ±10%, 2W	
R-137	31141-102	Resistor, Carbon, 100 ohms, ±10%, ½W	
R-138	31192-470	Resistor, Carbon, 47 ohms, ±10%, ¼W	
R-139	31141-330	Resistor, Carbon, 33 ohms, ±10%, ½W	
R-201	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-202	31135-822	Resistor, Carbon, 8.2K ohms, ±10%, 1W	
R-203	31161-8	Resistor, Wirewound, 200 ohms, 3W	
R-204	31141-683	Resistor, Carbon, 68K ohms, ±10%, ½W	
R-205	31141-223	Resistor, Carbon, 22K ohms, ±10%, ½W	
R-206	31141-470	Resistor, Carbon, 47 ohms, ±10%, ½W	
R-207	31135-153	Resistor, Carbon, 15K ohms, ±10%, 1W	
R-208	31141-101	Resistor, Carbon, 100 ohms, ±10%, ¼W	
R-209	31141-183	Resistor, Carbon, 18K ohms, ±10%, ½W	
R-210	31141-470	Resistor, Carbon, 47K ohms, ±10%, ½W	
R-211	31135-182	Resistor, Carbon, 1.8K ohms, ±10%, 1W	
R-212	31141-330	Resistor, Carbon, 33 ohms, ±10%, ½W	
R-213	31192-101	Resistor, Carbon, 100 ohms, ±10%, ¼W	
R-214	31192-103	Resistor, Carbon, 10K ohms, ±10%, ¼W	
R-215	31192-274	Resistor, Carbon, 270K ohms, ±10%, ¼W	
R-216	31192-101	Resistor, Carbon, 100 ohms, ±10%, ¼W	
R-217	31192-221	Resistor, Carbon, 220 ohms, ±10%, ¼W	
R-218	31192-470	Resistor, Carbon, 47 ohms, ±10%, ¼W	
R-219	31192-332	Resistor, Carbon, 3.3K ohms, ±10%, ¼W	
R-220	31192-561	Resistor, Carbon, 560 ohms, ±10%, ¼W	
R-221	31192-152	Resistor, Carbon, 1.5K ohms, ±10%, ¼W	
R-222	31192-674	Resistor, Carbon, 470 ohms, ±10%, ¼W	
R-223	31192-103	Resistor, Carbon, 10K ohms, ±10%, ¼W	
R-224	31192-151	Resistor, Carbon, 150 ohms, ±10%, ¼W	
R-225	31192-153	Resistor, Carbon, 15K ohms, ±10%, ¼W	
R-226	31192-153	Resistor, Carbon, 15K ohms, ±10%, ¼W	
R-227	31135-393	Reslstor, Carbon, 39K ohms, ±10%, 1W	
R-228	31135-273	Resistor, Carbon, 27K ohms, ±10%, 1W	
R-229	31135-273	Resistor, Carbon, 27K ohms, ±10%, 1W	
R-230	31192-103	Resistor, Carbon, 10K ohms, ±10%, ¼W	
R-231	31192-103	Resistor, Carbon, 10K ohms, ±10%, ¼W	
R-232	31192-222	Resistor, Carbon, 2.2K ohms, ±10%, ¼W	.....Com. HFO
R-233	31192-102	Resistor, Carbon, 1K ohms, ±10%, ¼W	
R-234	31161-20	Resistor, Wirewound, 150 ohms, 3W	
R-235	31192-101	Resistor, Carbon, 100 ohms, ±10%, ¼W	
R-236	31192-680	Resistor, Carbon, 68 ohms, ±10%, ¼W	
R-237	31175-18	Resistor, Wirewound, 15K ohms, ±5%, 7W	
R-238	31192-680	Resistor, Carbon, 68 ohms, ±10%, ¼W	

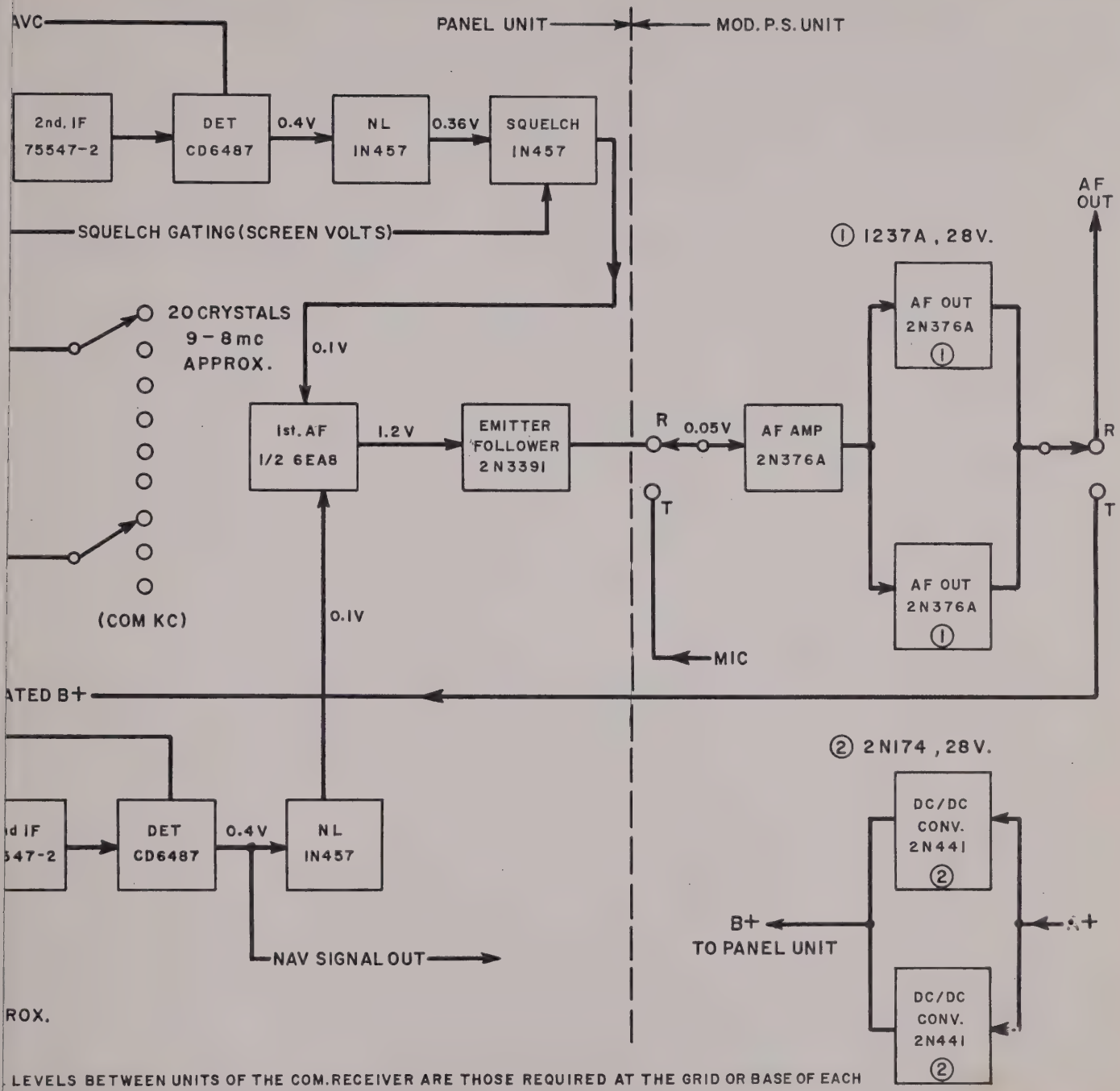
SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
R-301		Not used	
R-302	31141-221	Resistor, Carbon, 220 ohms, ±10%, ½W	
R-303	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-304	31141-223	Resistor, Carbon, 22K ohms, ±10%, ½W	
R-305	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-306	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-307	31141-471	Resistor, Carbon, 470 ohms, ±10%, ½W	
R-308	31141-104	Resistor, Carbon, 100K ohms, ±10%, ½W	
R-309	31192-681	Resistor, Carbon, 680 ohms, ±10%, ¼W	
R-310	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-311	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	
R-312	31192-471	Resistor, Carbon, 470 ohms, ±10%, ¼W	
R-313	31192-222	Resistor, Carbon, 2.2K ohms, ±10%, ¼W	
R-314	31192-153	Resistor, Carbon, 15K ohms, ±10%, ¼W	
R-315	31141-685	Resistor, Carbon, 6.8 Meg. ohms, ±10%, ½W	
R-316	31192-680	Resistor, Carbon, 68 ohms, ±10%, ½W	
R-317	31141-474	Resistor, Carbon, 470K ohms, ±10%, ½W	
R-318	32040-3	Potentiometer, 1 Meg. Vol. Cont.	
R-319	31192-683	Resistor, Carbon, 68K ohms, ±10%, ¼W	
R-320	31192-683	Resistor, Carbon, 68K ohms, ±10%, ¼W	
R-321	31141-153	Resistor, Carbon, 15K ohms, ±10%, ½W	
R-322	31192-392	Resistor, Carbon, 3.9K ohms, ±10%, ¼W	
R-323	31141-681	Resistor, Carbon, 680 ohms, ±10%, ½W	
R-324	31141-222	Resistor, Carbon, 2.2K ohms, ±10%, ½W	
R-325	31192-152	Resistor, Carbon, 1.5K ohms, ±10%, ¼W	
R-326	31192-332	Resistor, Carbon, 3.3K ohms, ±10%, ¼W	
R-327	31192-561	Resistor, Carbon, 560 ohms, ±10%, ¼W	
R-328	31192-101	Resistor, Carbon, 100 ohms, ±10%, ¼W.	
R-329	31135-153	Resistor, Carbon, 15K ohms, ±10%, 1W	
R-330	31141-153	Resistor, Carbon, 15K ohms, ±10%, ½W	
R-331	31192-681	Resistor, Carbon, 680 ohms ±10%, ¼W	
R-332	31192-222	Resistor, Carbon, 2.2K ohms, ±10%, ¼W	
R-333	31192-153	Resistor, Carbon, 15K ohms, ±10%, ¼W	
R-334	31192-151	Resistor, Carbon, 150 ohms, ±10%, ¼W	
R-335	31192-103	Resistor, Carbon, 10K ohms, ±10%, ¼W	
R-336	31192-680	Resistor, Carbon, 68 ohms, ±10%, ¼W	
R-337	31192-103	Resistor, Carbon, 10K ohms, ±10%, ¼W	
R-338	31192-101	Resistor, Carbon, 100 ohms, ±10%, ¼W	
R-339	31192-222	Resistor, Carbon, 2.2K ohms, ±10%, ¼W	
R-340	31192-151	Resistor, Carbon, 150 ohms, ±10%, ¼W	
R-341	31141-151	Resistor, Carbon, 150 ohms, ±10%, ¼W	
R-342	31192-220	Resistor, Carbon, 22 ohms, ±10%, ¼W	
R-401	31141-821	Resistor, Carbon, 820 ohms, ±10%, ½W	
R-402	31141-471	Resistor, Carbon, 470 ohms, ±10%, ½W	
R-403	31179-1	Resistor, Temp. Sensitive .47 ±10%, +TC	
R-404	31141-471	Resistor, Carbon, 470 ohms, ±10%, ½W	
R-405	31136-270	Resistor, Carbon, 27 ohms, ±10%, 2W	
R-406	31135-221	Resistor, Carbon, 220 ohms, ±10%, 1W	Mod. Pwr. 14V
R-406	31135-681	Resistor, Carbon, 680 ohms, ±10%, 1W	Mod. Pwr. 28V
R-407	31141-151	Resistor, Carbon, 150 ohms, ±10%, ½W	Mod. Pwr. 14V
R-407	31141-221	Resistor, Carbon, 220 ohms, ±10%, ½W	Mod. Pwr. 28V
R-408	31141-822	Resistor, Carbon, 8.2K ,±10%, ½W	
R-409	31175-11	Resistor Wirewound, 75 ohms, ±5%, 5W	
R-410	32045-5	Resistor, Variable Wirewound, 2K, 2W	
R-411	31135-220	Resistor, Carbon, 22 ohms, ±10%, 1W	Mod. Pwr. 14V
R-501	31141-180	Resistor, Carbon, 18 ohms, ±10%, ½W	
R-501	31141-101	Resistor, Carbon, 100 ohms, ±10%, ½W	
R-502	31136-331	Resistor, Carbon, 330 ohms, ±10%, 2W	
R-502	31136-102	Resistor, Carbon, 1K, ±10%, 2W	
R-503	31136-331	Resistor, Carbon, 330 ohms, ±10%, 2W	Mod. Pwr. 28V
R-503	31136-102	Resistor, Carbon, 1K, ±10%, 2W	Mod. Pwr. 28V
R-504	31141-180	Resistor, Carbon, 18 ohms, ±10%, ½W	Mod. Pwr. 14V
R-504	31141-101	Resistor, Carbon, 100 ohms, ±10%, ½W	Mod. Pwr. 28V
R-505	31135-274	Resistor, Carbon, 270K, ±10%, 1W	
R-506	31136-101	Resistor, Carbon, 100 ohms, ±10%, 2W	
R-507	31175-11	Resistor, Wirewound, 75 ohms, ±5%, 5W	
R-508	31141-330	Resistor, Carbon, 33 ohms, ±10%, ½W	
R-509	31141-220	Resistor, Carbno, 22 ohms, ±10%, ½W	
R-510	31141-330	Resistor, Carbon, 33 ohms, ±10%, ½W	

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		S, SWICHES	
S-101		Part of R-125	
S-102		Part of R-125	
S-103		Part of L-103	
S-105		Part of L-105	
S-107		Part of L-107	
S-109		Part of L-109	
S-110		Part of L-110	
S-111		Part of L-111	
S-201		Part of L-201	
S-202	61395-1	Switch, XTAL, HFO Comm. (Front)	
S-203	61396-1	Switch, XTAL, HFO Comm.(Rear)	
S-204		Part of S-220	
S-205		Part of L-205	
S-209		Part of L-209	
S-212		Part of L-212	
S-216		Part of L-216	
S-219		Part of L-219	
S-220	61409-101	Assembly, Switch, XTAL, Sel. KC.	
S-301	61389-1	Switch, XTAL, HFO Nav.	
S-302		Part of L-302	
S-303	61389-1	Switch	
S-304		Part of L-304	
S-305	61483-1	Switch Loc/G.S. Mc	
S-306		Part of L-306	
S-307		Part of L-307	
S-308		Part of L-308	
S-309	61482-1	Switch DME Mc	
S-310	61425-2	Switch Loc/GS/DME Kc	
S-311		Part of L-311	
S-312	61426-1	Switch Loc/GS/DME Kc	
S-313		Part of R-318	
S-315		Part of L-315	
		T, TRANSFORMERS	
T-101	11497-1	Transformer, Comm. HF IF Input	Com. Rcvr.
T-102	11502-1	Transformer, Comm. HF IF Output	Com. Rcvr.
T-103	11671-101	Transformer, Comm. LF IF Input	Com. Rcvr.
T-104	11500-1	Transformer, Comm. LF IF Interstage	Com. Rcvr.
T-105	11496-1	Transformer, Comm. LF IF Output	
T-201	11505-1	Transformer, Comm. LFO	
T-301	11672-101	Transformer, Nav. HF IF	Nav. Rcvr.
T-302	11499-1	Transformer, Nav. LF IF Input	Nav. Rcvr.
T-303	11498-1	Transformer, Nav. LF IF Output	Nav. Rcvr.
T-401	11821-102	Transformer, Driver	
T-402	11821-105	Transformer Audio Output 13.75	Mod. Pwr. 14V
T-402	11633-102	Transformer Audio Output 27.5	Mod. Pwr. 28V
T-501	11670-1	Transformer Power 13.2 V	Mod. Pwr. 14V
T-501	11629-1	Transformer Power 27.5 V	Mod. Pwr. 28V

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		V, ELECTRON TUBES	
V-101		Tube, Electron, 6BH6	
V-102		Tube, Electron, 6AK5	
V-103		Tube, Electron, 6EA8	
V-104		Tube, Electron, 6BJ6	
V-201		Tube, Electron, 7551	
V-202		Tube, Electron, 8106	
V-203		Tube, Electron, 8106	
V-204	75401-1	Tube, Electron, 6AR8 (Special)	
V-301		Tube, Electron, 6BJ6	Nav. Rcvr.
V-302		Tube, Electron, 6CB6	Nav. Rcvr.
V-303		Tube, Electron, 6CB6	Nav. Rcvr.
V-304		Tube, Electron, 6CW4	
		XT, CRYSTALS (QUARTZ)	
XT-101	72007-235	Crystal quartz submin. 63.2375 Mc, 117 Mc	Com. Transceiver
XT-102	72007-236	Crystal quartz submin. 63.7375 Mc, 118 Mc	Com. Transceiver
XT-103	72007-237	Crystal quartz submin. 64.2375 Mc, 119 Mc	Com. Transceiver
XT-104	72007-238	Crystal quartz submin. 64.7375 Mc, 120 Mc	Com. Transceiver
XT-105	72007-239	Crystal quartz submin. 65.2375 Mc, 121 Mc	Com. Transceiver
XT-106	72007-240	Crystal quartz submin. 65.7375 Mc, 122 Mc	Com. Transceiver
XT-107	72007-241	Crystal quartz submin. 66.2375 Mc, 123 Mc	Com. Transceiver
XT-108	72007-242	Crystal quartz submin. 66.7375 Mc, 124 Mc	Com. Transceiver
XT-109	72007-243	Crystal quartz submin. 67.2375 Mc, 125 Mc	Com. Transceiver
XT-110	72007-244	Crystal quartz submin. 67.7375 Mc, 126 Mc	Com. Transceiver
XT-111	72007-245	Crystal quartz submin. 68.2375 Mc, 127 Mc	Com. Transceiver
XT-112	72007-246	Crystal quartz submin. 68.7375 Mc, 128 Mc	Com. Transceiver
XT-113	72007-247	Crystal quartz submin. 69.2375 Mc, 129 Mc	Com. Transceiver
XT-114	72007-248	Crystal quartz submin. 69.7375 Mc, 130 Mc	Com. Transceiver
XT-115	72007-249	Crystal quartz submin. 70.2375 Mc, 131 Mc	Com. Transceiver
XT-116	72007-250	Crystal quartz submin. 70.7375 Mc, 132 Mc	Com. Transceiver
XT-117	72007-251	Crystal quartz submin. 71.2375 Mc, 133 Mc	Com. Transceiver
XT-118	72007-252	Crystal quartz submin. 71.7375 Mc, 134 Mc	Com. Transceiver
XT-119	72007-253	Crystal quartz submin. 72.2375 Mc, 135 Mc	Com. Transceiver
XT-120	72007-254	Crystal quartz submin. 9.475 Mc, .00 Mc	Com. Transceiver
XT-121	72007-255	Crystal quartz submin. 9.425 Mc, .05 Mc	Com. Transceiver
XT-122	72007-256	Crystal quartz submin. 9.375 Mc, .10 Mc	Com. Transceiver
XT-123	72007-257	Crystal quartz submin. 9.325 Mc, .15 Mc	Com. Transceiver
XT-124	72007-258	Crystal quartz submin. 9.275 Mc, .20 Mc	Com. Transceiver
XT-125	72007-259	Crystal quartz submin. 9.225 Mc, .25 Mc	Com. Transceiver
XT-126	72007-260	Crystal quartz submin. 9.175 Mc, .30 Mc	Com. Transceiver
XT-127	72007-261	Crystal quartz submin. 9.125 Mc, .35 Mc	Com. Transceiver
XT-128	72007-262	Crystal quartz submin. 9.075 Mc, .40 Mc	Com. Transceiver
XT-129	72007-263	Crystal quartz submin. 9.025 Mc, .45 Mc	Com. Transceiver
XT-130	72007-264	Crystal quartz submin. 8.975 Mc, .50 Mc	Com. Transceiver
XT-131	72007-265	Crystal quartz submin. 8.925 Mc, .55 Mc	Com. Transceiver
XT-132	72007-266	Crystal quartz submin. 8.875 Mc, .60 Mc	Com. Transceiver
XT-133	72007-267	Crystal quartz submin. 8.825 Mc, .65 Mc	Com. Transceiver
XT-134	72007-268	Crystal quartz submin. 8.775 Mc, .70 Mc	Com. Transceiver
XT-135	72007-269	Crystal quartz submin. 8.725 Mc, .75 Mc	Com. Transceiver

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
XT-136	72007-270	Crystal quartz submin. 8.675 Mc, .80 Mc	Com. Transceiver
XT-137	72007-271	Crystal quartz submin. 8.625 Mc, .85 Mc	Com. Transceiver
XT-138	72007-272	Crystal quartz submin. 8.575 Mc, .90 Mc	Com. Transceiver
XT-139	72007-273	Crystal quartz submin. 8.525 Mc, .95 Mc	Com. Transceiver
XT-140	72007-274	Crystal quartz submin. 96.550 Mc, 108 Mc	Com. Transceiver
XT-141	72007-275	Crystal quartz submin. 97.550 Mc, 109 Mc	Com. Transceiver
XT-142	72007-276	Crystal quartz submin. 98.550 Mc, 110 Mc	Com. Transceiver
XT-143	72007-277	Crystal quartz submin. 99.550 Mc, 111 Mc	Com. Transceiver
XT-144	72007-278	Crystal quartz submin. 100.550 Mc, 112 Mc	Com. Transceiver
XT-145	72007-279	Crystal quartz submin. 101.550 Mc, 113 Mc	Com. Transceiver
XT-146	72007-280	Crystal quartz submin. 102.550 Mc, 114 Mc	Com. Transceiver
XT-147	72007-281	Crystal quartz submin. 103.550 Mc, 115 Mc	Com. Transceiver
XT-148	72007-282	Crystal quartz submin. 104.550 Mc, 116 Mc	Com. Transceiver
XT-149	72007-283	Crystal quartz submin. 105.550 Mc, 117 Mc	Com. Transceiver
	3077-503	Kit, Crystals—90-360 Channel Conversion	Com. Transceiver

SYMBOL	NARCO PART NO.	DESCRIPTION	FUNCTION OR APPLICATION
		MISCELLANEOUS (NO SYMBOL)	
None	41147-3	Socket, Pilot Light	1-101 Panel Lamp
"	41225-2	Socket, Pilot Light	1-102 Panel Lamp
"	42033-5	Tube Socket, 7-Pin	All 7-Pin Min. Tubes
"	42034-3	Tube Socket, 9-Pin	V-103
"	42034-6	Tube Socket, 9-Pin	V-202, 203
"	42060-4	Tube Socket, 9-Pin, Recessed	V-201, 204
"	55020-2	Insulator, Transistor	Mod. Pwr. Unit
"	55520-1	Crystal Holder, Nav. Mc.	Nav. Mc.
"	56409-1	Cover, Top, Osc., Nav.	Nav. Rec.
"	56410-1	Cover, Bottom, Osc., Nav.	Nav. Rec.
"	56426-1	Cover, Bottom, Osc., Comm.	Comm.
"	56438-1	Cover, Dust	Mod. Pwr. Unit
"	56461-2	Panel, Trim	Panel Unit
"	56477-1	Cover, Top, Osc., Comm.	Comm.
"	56480-1	Strap, Grounding	Nav. Comm. Shaft
"	56482-1	Spring, Grounding	Trans. Comm.
"	61377-1	Detent, Adjustable, Nav. Kc	Nav. Kc.
"	61401-1	Detent Roller	Comm. Kc.
"	61402-1	Detent Spring	Comm. Kc.
"	61404-101	Assembly, Detent Roller	Comm. Kc.
"	66507-1	Fuse Holder	Mod. Pwr. Unit
"	81312-1	Washer, Curved Spring	Case Fastener
"	81622-3	Clip	Mod. Pwr. Unit
"	84067-3	Stud, Southco (Wing)	Case Fastener
"	84069-1	Receptacle, Southco	Case Fastener
"	84071-1	Hairpin Retainer	Case Fastener
"	84071-2	Cotter, Hairpin	Nav. Comm. Shaft
"	88129-2	Knob, Volume	Volume
"	88148-2	Knob, Squelch	Sq.



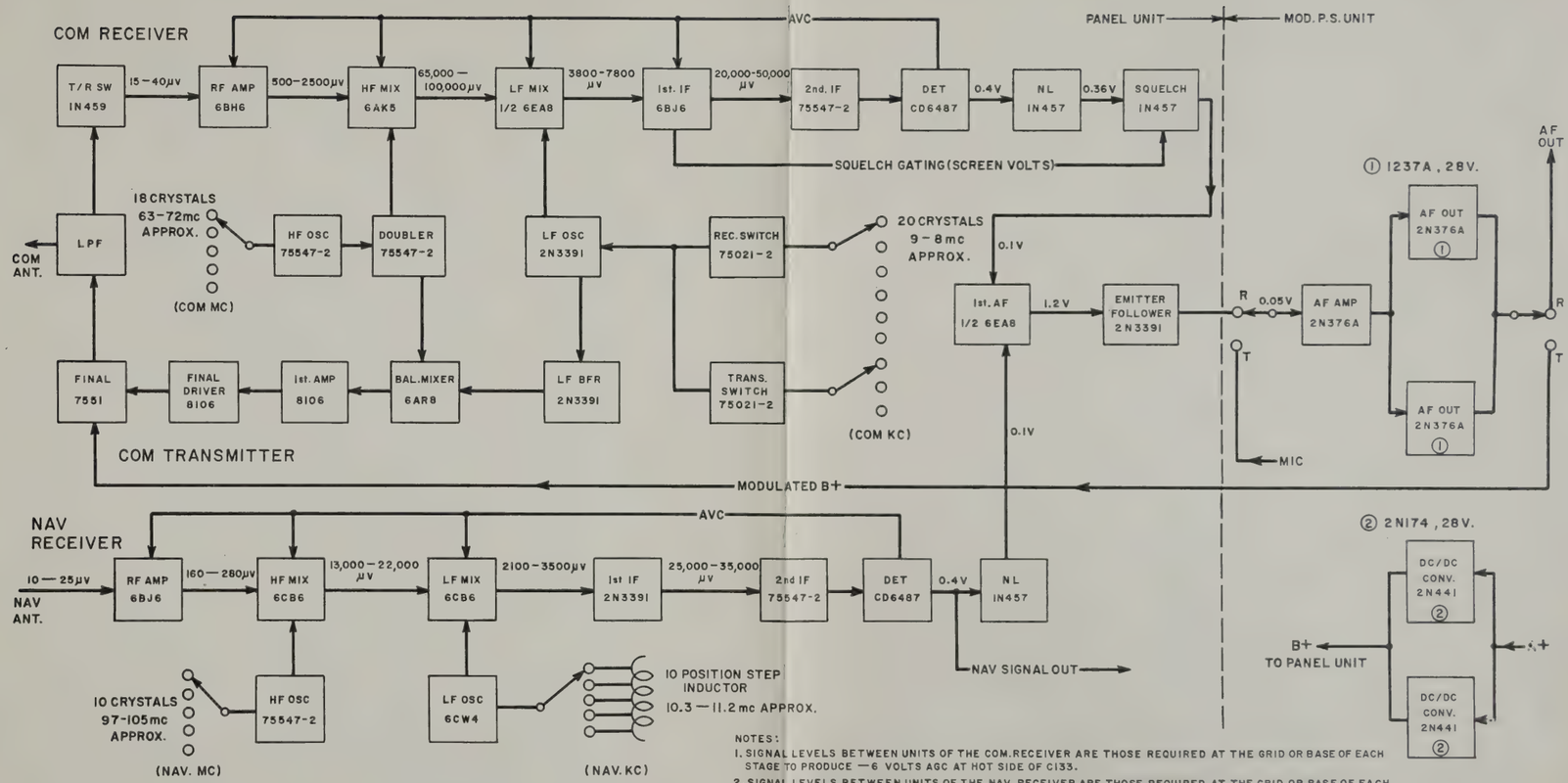
LEVELS BETWEEN UNITS OF THE COM. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH TO PRODUCE —6 VOLTS AGC AT HOT SIDE OF C133.

LEVELS BETWEEN UNITS OF THE NAV. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH TO PRODUCE —15 VOLTS AGC AT LEAD 5 OF CP301.

BOVE SIGNALS ARE APPROXIMATE VALUES, PROVIDED FOR RAPID CHECKS. SIGNAL LEVELS DEPEND ON THE F INDIVIDUAL STAGES AND ON THE INTERNAL IMPEDANCE OF THE SIGNAL GENERATOR USED.

L LEVELS BETWEEN UNITS OF THE AUDIO PORTIONS OF BOTH RECEIVERS AND THE COMMON AUDIO AMPLIFIERS HOSE REQUIRED AT THE GRID OR BASE OF EACH STAGE TO PRODUCE 4.5 WATTS AUDIO OUTPUT AT 400 CPS.

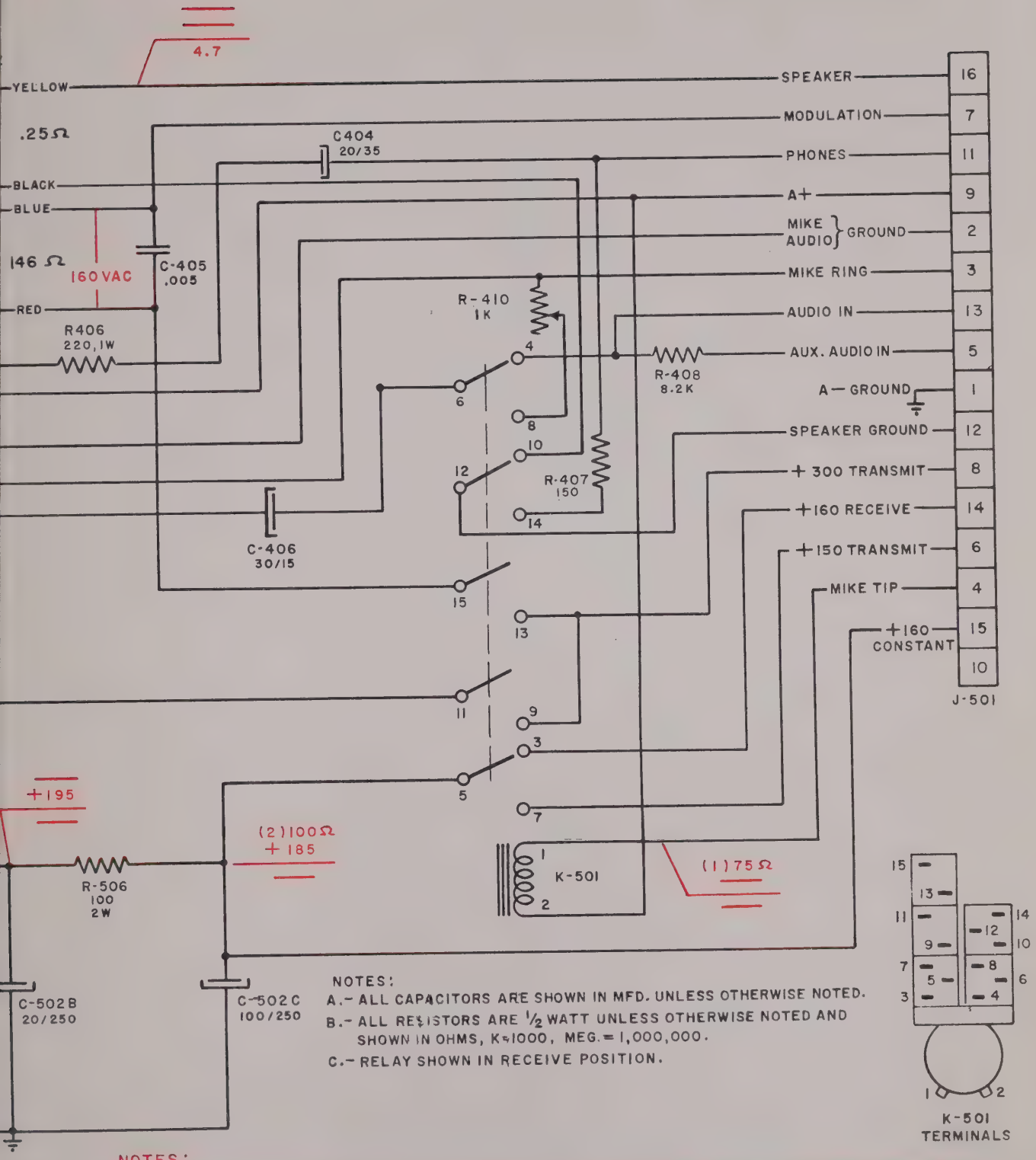
Figure 28.
BLOCK DIAGRAM
narco Mark 12A COM/NAV Equipment,
with Signal Level Information.



NOTES:

1. SIGNAL LEVELS BETWEEN UNITS OF THE COM. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH STAGE TO PRODUCE —6 VOLTS AGC AT HOT SIDE OF C133.
2. SIGNAL LEVELS BETWEEN UNITS OF THE NAV. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH STAGE TO PRODUCE —15 VOLTS AGC AT LEAD 5 OF CP301.
3. THE ABOVE SIGNALS ARE APPROXIMATE VALUES, PROVIDED FOR RAPID CHECKS. SIGNAL LEVELS DEPEND ON THE GAIN OF INDIVIDUAL STAGES AND ON THE INTERNAL IMPEDANCE OF THE SIGNAL GENERATOR USED.
4. SIGNAL LEVELS BETWEEN UNITS OF THE AUDIO PORTIONS OF BOTH RECEIVERS AND THE COMMON AUDIO AMPLIFIERS ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH STAGE TO PRODUCE 4.5 WATTS AUDIO OUTPUT AT 400 CPS.

Figure 28.
BLOCK DIAGRAM
narco Mark 12A COM/NAV Equipment,
with Signal Level Information.



NOTES:

A.– ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.

B.– ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.

C.– RELAY SHOWN IN RECEIVE POSITION.

NOTES:

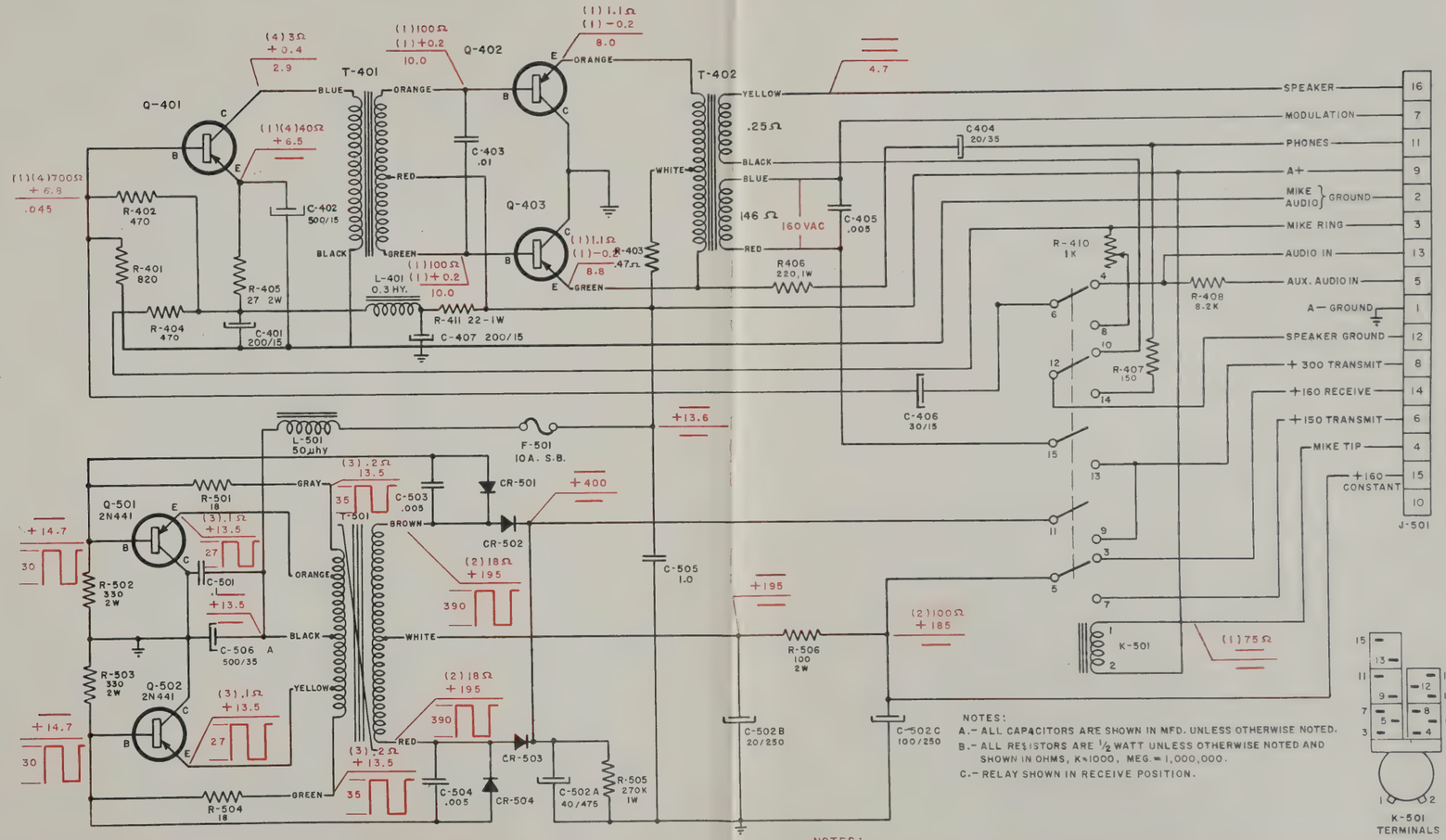
RESISTANCE READINGS TAKEN WITH CONNECTOR DISCONNECTED. OTHER READINGS TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS AUDIO OUT, WITH NORMAL 13.75 VOLTS INTO POWER CABLE AT MARK-12A (AUDIO FREQUENCY 1000 CPS).

ALL DC MEASUREMENTS WITH RCA VOLTOMYST VTVM OR EQUIVALENT.

ALL AC MEASUREMENTS WITH BALLANTINE AC VTVM OR EQUIVALENT.

ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUIVALENT.

Figure 30.
SCHEMATIC, *narco* Mark 12A,
MOD-PWR UNIT T12MP-12A,
for CNPA 144-A



TEST DATA :

RESISTANCE

DC VOLTAGE & POLARITY

AC VOLTAGE OR WAVESHAPE AND P-P VOLTAGE

TEST DATA NOTES :

(1) MEASURED WITH RESPECT TO A+, PIN 9.

(2) MEASURED WITH RESPECT TO WHITE LEAD OF T501.

(3) MEASURED WITH RESPECT TO BLACK LEAD OF T501.

(4) MEASURED WITH Q-401 REMOVED.

NOTES :

A.– ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.

B.– ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.

C.– RELAY SHOWN IN RECEIVE POSITION.

K-501 TERMINALS

NOTES :

RESISTANCE READINGS TAKEN WITH CONNECTOR DISCONNECTED. OTHER READINGS TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS AUDIO OUT, WITH NORMAL 13.75 VOLTS INTO POWER CABLE AT MARK-12A (AUDIO FREQUENCY 1000 CPS).

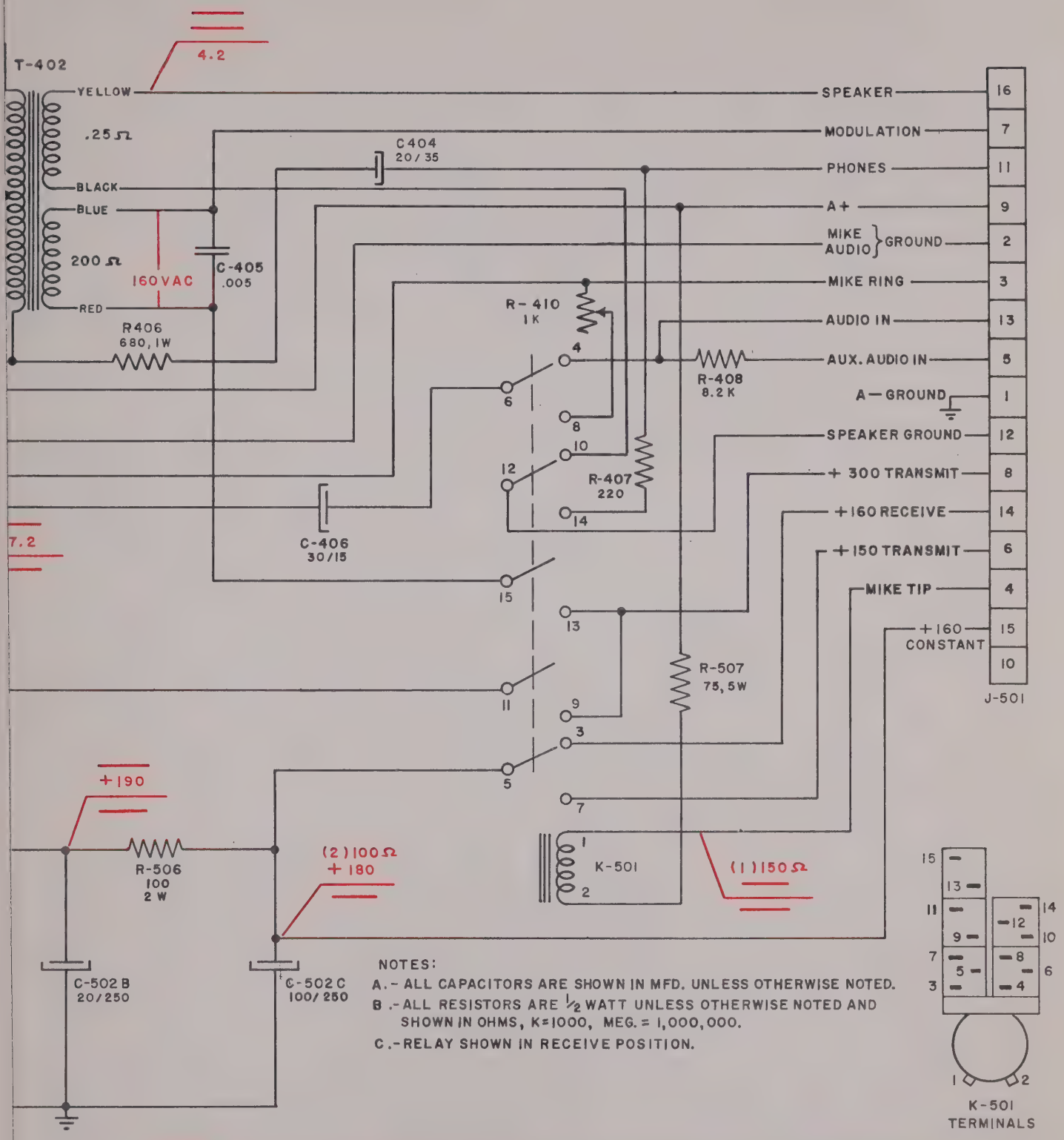
ALL DC MEASUREMENTS WITH RCA VOLTOMYST VTVM OR EQUIVALENT.

ALL AC MEASUREMENTS WITH BALLANTINE AC VTVM OR EQUIVALENT.

ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUIVALENT.

T-02211
ECN-0000
6-26-65

Figure 30.
SCHEMATIC, *narco* Mark 12A,
MOD-PWR UNIT T12MP-12A,
for CNPA 144-A



NOTES:

A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.

B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG. = 1,000,000.

C.- RELAY SHOWN IN RECEIVE POSITION.

NOTES:

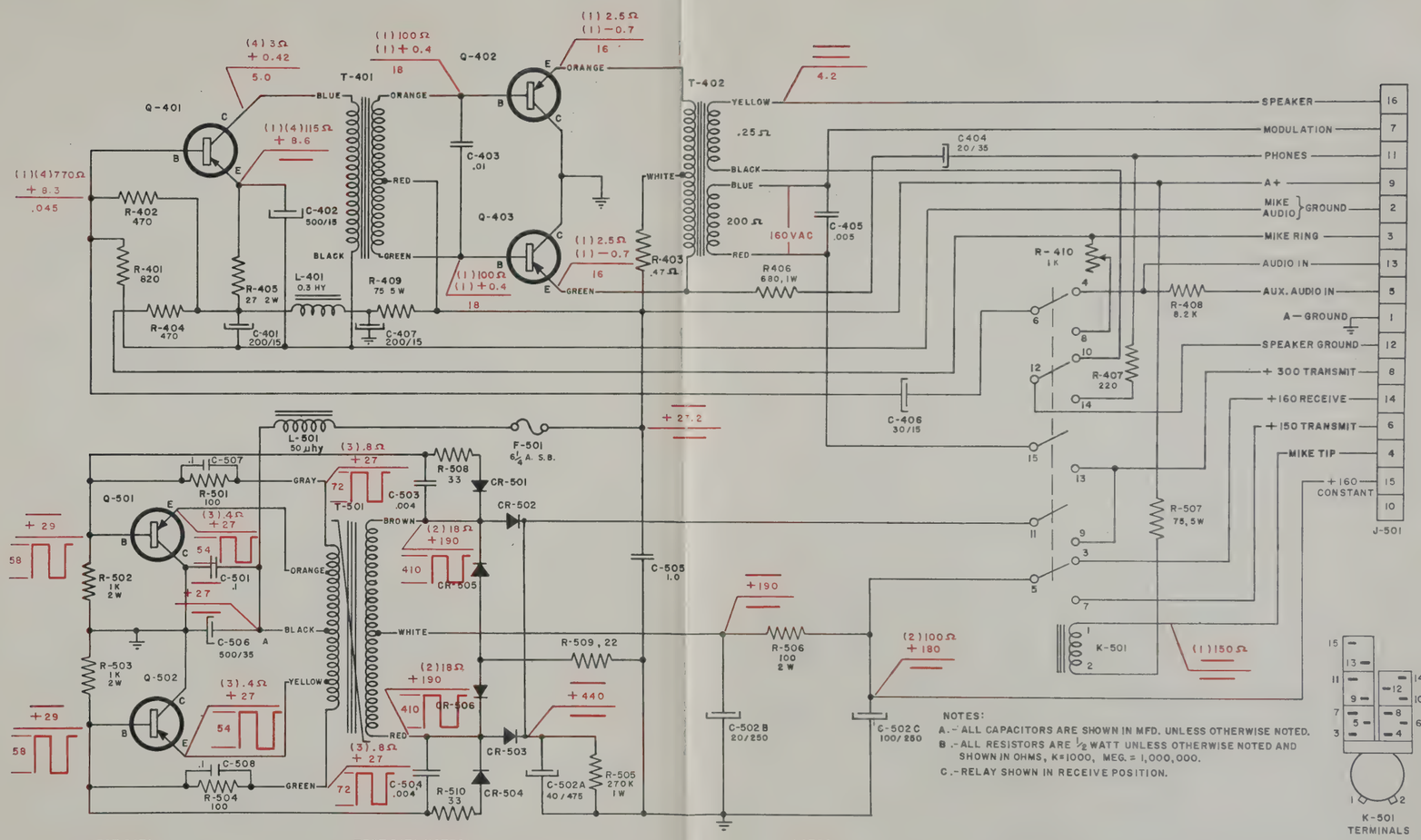
RESISTANCE READINGS TAKEN WITH CONNECTOR DISCONNECTED. OTHER READINGS TAKEN WITH SET IN RECEIVE OPERATION AND 4.5 WATTS AUDIO OUT, WITH NORMAL 27.50 VOLTS INTO POWER CABLE AT MARK-12A (AUDIO FREQUENCY 1000 CPS).

ALL DC MEASUREMENTS WITH RCA VOLTOMYST VTVM OR EQUIVALENT.

ALL AC MEASUREMENTS WITH BALLANTINE AC VTVM OR EQUIVALENT.

ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUIVALENT.

Figure 31.
SCHEMATIC, *narco* Mark 12A,
MOD-PWR UNIT, T-24MP-12A,
for CNPB 144-A.



T-02212
ECN-0000
6-25-66

Figure 31.
SCHEMATIC, *narco* Mark 12A,
MOD-PWR UNIT, T-24MP-12A,
for CNPB 144-A.
- 75 - Extension.

NARCO AVIONICS

Supplement 1

Place this sheet at the front of the original manual (3077-600) to indicate that Supplement 1 is included in this Maintenance Manual.

MARK 12A

VHF TRANSCEIVER and NAVIGATION RECEIVER

with

T12MP-12A or T24MP-12A MODULATOR-POWER UNIT

MAINTENANCE MANUAL

ISSUE - 1

Supplement – 1, for CN-144-A12, thru CN-144-B6

pages 76 thru 94

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A.

January, 1968

MARK 12A

VHF TRANSCEIVER and NAVIGATION RECEIVER

with

T12MP-12A or T24MP-12A MODULATOR-POWER UNIT

MAINTENANCE MANUAL

ISSUE - 1

Supplement – 1, for CN-144-A12, thru CN-144-B6

Remove the front cover sheet and place it at the front of this Mark 12A Maintenance Manual to indicate that the manual has been updated to include all chassis changes up to CN-144-B6.

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NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

INTRODUCTION.

This supplement documents the changes in Chassis Numbers CN-144-A12 thru CN-144-B6 of the Mark 12A VHF Transceiver and Navigation Receiver.

The Replacement Parts List in this supplement provides identification of those parts deleted, added, or changed. The Chassis Number shown indicates when this action took place. When ordering other components, please refer to Section 7 of the original manual.

Upon inserting Figures 32 thru 37, the manual will contain a schematic for each chassis number of the Mark 12A wherein electrical modifications were accomplished.

PRODUCT MODIFICATION SUMMARY

CN-144-A12 and CN-144-B

No electrical or mechanical changes. Factory procedures resulted in chassis number changes.

CN-144-B1, Figure 32 of Supplement 1

Resistor R-239 added to the COM LFO buffer/amplifier Q-203 to provide better stability while in the operating mode.

CN-144-B2, Figure 33 of Supplement 1.

Original parts C-109 and C-119 become unavailable. New parts (two 22019-1) were substituted; however, it was necessary to parallel C-109 with a second capaciator C-172 (PN 21201-239) as well as paralleling C-119 with C-173 (PN 21201-239) to obtain the required capacitance.

Choke coil L-313 was changed to a lower tolerance (±5%) unit for easier tracking of the NAV LFO.

CN-144-B3, Figure 34 of Supplement 1.

Capacitor C-370 removed, C-344 and C-346 relocated grounds to Q-301 case ground, and other related rewiring. Details covering this "birdie-fix" change is found elsewhere in this supplement.

CN-144-B4, Figure 35 of Supplement 1.

Capacitor C-344 changed to PN 24049-180 (18 pf). Capacitor C-346 changed to PN 24049-360 (36 pf).

Due to change in B-3 chassis, it was found that tuning elements C-345 and L-310 in the NAV HFO were running out of range for a clean peak.

Added C-275 across C-251 COM HFO to make up for slight variations of L-218.

CN-144-B5, Figure 36 of Supplement 1.

Removed C-371, a 1000 pf capacitor, and inserted a new capacitor P/N 21281-2 (470 pf) and identified it as C-372. This change eliminated the low frequency "growl" in the NAV receiver due to bleed thru of the 90/150 cycle modulation on localizer channels.

CN-144-B6, Figure 37 of Supplement 1.

Capacitor C-344 changed to P/N 24049-220 (22 pf). Capacitor C-346 changed to P/N 24049-430 (43 pf). This change provided improved range of C-345 and L-310 (NAV HFO).

CN-144-B3 "BIRDIE-FIX"

In the Mark 12A, Chassis Numbered below CN-144-B3, spurious beats developed within the receiver caused interference when tuned to some combinations of Communication and Navigation Channels. A combination of harmonics from the NAV and COM HFO were heterodyned in the NAV mixer to produce undesired beats. This interference has been minimized in all Chassis above CN-144-B3.

Photo L shows the NAV HFO circuit before the modification (Chassis Nos. below B3) and Photo M shows the NAV HFO circuit after modification (Chassis Nos. B3 and above).

The following procedure is given to modify the chassis to incorporate this "birdie-fix":

NOTE

Photos L and M show all applicable parts. Refer to these figures for BEFORE and AFTER views of the underside of the chassis.

1. Remove C-370 (base/emitter of Q-301, NAV HFO)
2. Relocate the ground points of C-347 and C-343 to the same location as the transistor shield (capacitor lead lengths should be almost equal with capacitors flat against the chassis). Note lead dress of C-347 from the switch wafer through the shield area to ground.
3. Install ground strap on HFO cover (remove two screws from cover and use to secure ground strap, Narco parts 54514-1 and 56455-1, as shown in Figure M.

GENERAL UPDATE

Inadvertantly the basic maintenance manual was produced containing several minor errors. Please refer to your manual and make the following corrections:

Page 8, paragraph 1-B, 4. Navigation Receiver
change Overall Selectivity to:
6 db (nose), ±20 Kc/s minimum bandwidth
60 db (skirt), ±95 Kc/s maximum bandwidth

Page 26, paragraph 5-F ,1h
change to: Normal Indication: 300 μv maximum input for 0.4 VAC.

Page 30, paragraph 5-G, 3a
change to: (See Fig. 13, page 41).

Page 30/31, paragraphs 5-G, 4c, e, and alternate method d.
change references to C-345, to: C-353 (3 places).

Page 34, paragraph 5-J.
Change C-335 in third subparagraph to: C-355 (2 places).

Page 46, Figure 22 Title
Change Narco VOA-4 to VOA-6

Page 48, Figure 25 Title
Change Narco VOA-6 to VOA-4/5.

Page 66/67, change XT 101 thru XT 139 to XT 201 thru XT 239.

Page 67, change XT 140 thru XT 149 to XT 301 thru XT-310 plus change application from: COM Transceiver, to: NAV Receiver.

REPLACEMENT PARTS LIST

The below list of parts supplements the Replacement Parts List (Section 7) and provides the support information resulting from changes made in chassis numbered CN-144-A12 thru CN-144-B6. When ordering these parts from NARCO AVIONICS, please list the chassis number and the source used to obtain the part number (supplement parts list).

MISCELLANEOUS MECHANICAL PARTS

Part Number	DESCRIPTION	Reference
1441-403	Knob, COM	(see figure 1)
1441-404	Knob, NAV	(see figure 1)
88160-2	Knob, COM/NAV Fractional	(see figure 1)
1444-102	Base Plate, Power Unit	(see figure 19)
61481-1	Shaft and Detent Assy Mc NAV	(see photo A and C)
1441-618	Shaft, Kc	(see photo C)
1441-616	Shaft, Mc tuning COM side	(see photo A and C)
1441-610	NAV LFO SUB-ASSY	(see photo K)
1441-628	NAV LFO SUB-ASSY (Less Crystals)	(see photo K)
54514-1	Spring, ground	(used on CN-144-B3 and above)
56455-1	Strap, ground	(used on CN-144-B3 and above)
61503-1	Switch, Rotary, Power ON/OFF	(see photo A)

ELECTRICAL PARTS

Symbol	Narco Part No.	DESCRIPTION	Starting with Chassis Number
C-109 (changed)	22019-1	Capacitor, Variable, Plunger, 0.5-4.5 pf, 500V	CN-144-B2
C-119 (changed)	22019-1	Capacitor, Variable, Plunger, 0.5-4.5 pf, 500V	CN-144-B2
C-172 (added)	21201-239	Capacitor, Ceramic, tub., 3.3 pf ±10%, 500V, NPO	CN-144-B2
C-173 (added)	21201-239	Capacitor, Ceramic, tub., 3.3 pf ±10%, 500V, NPO	CN-144-B2
C-275 (added)	24516-229	Capacitor, Disc, Ceramic, 2.2 pf ±0.5%, 500V	CN-144-B4
C-344 (changed)	24049-108	Capacitor, Disc, Ceramic, 18 pf ±5%, 500V	CN-144-B4
C-344 (changed)	24049-220	Capacitor, Dipped Mica, 22 pf ±5%, 500V	CN-144-B6
C-346 (changed)	24049-360	Capacitor, Dipped Mica, 36 pf ±5%, 500V	CN-144-B4
C-346 (changed)	24049-430	Capacitor, Dipped Mica, 43 pf ±5%, 500V	CN-144-B6
C-370 (removed)			CN-144-B3
C-372 (added)	21291-2	Capacitor, Disc, Ceramic, 470 pf ±10%, 500V	CN-144-B5
L-313 (changed)	11138-28	RF Choke, Insulated, 0.47 uH ±5%	CN-144-B2
R-239 (added)	31192-683	Resistor, Fixed, Carbon, 68KΩ ±10%, 1/4w	CN-144-B1

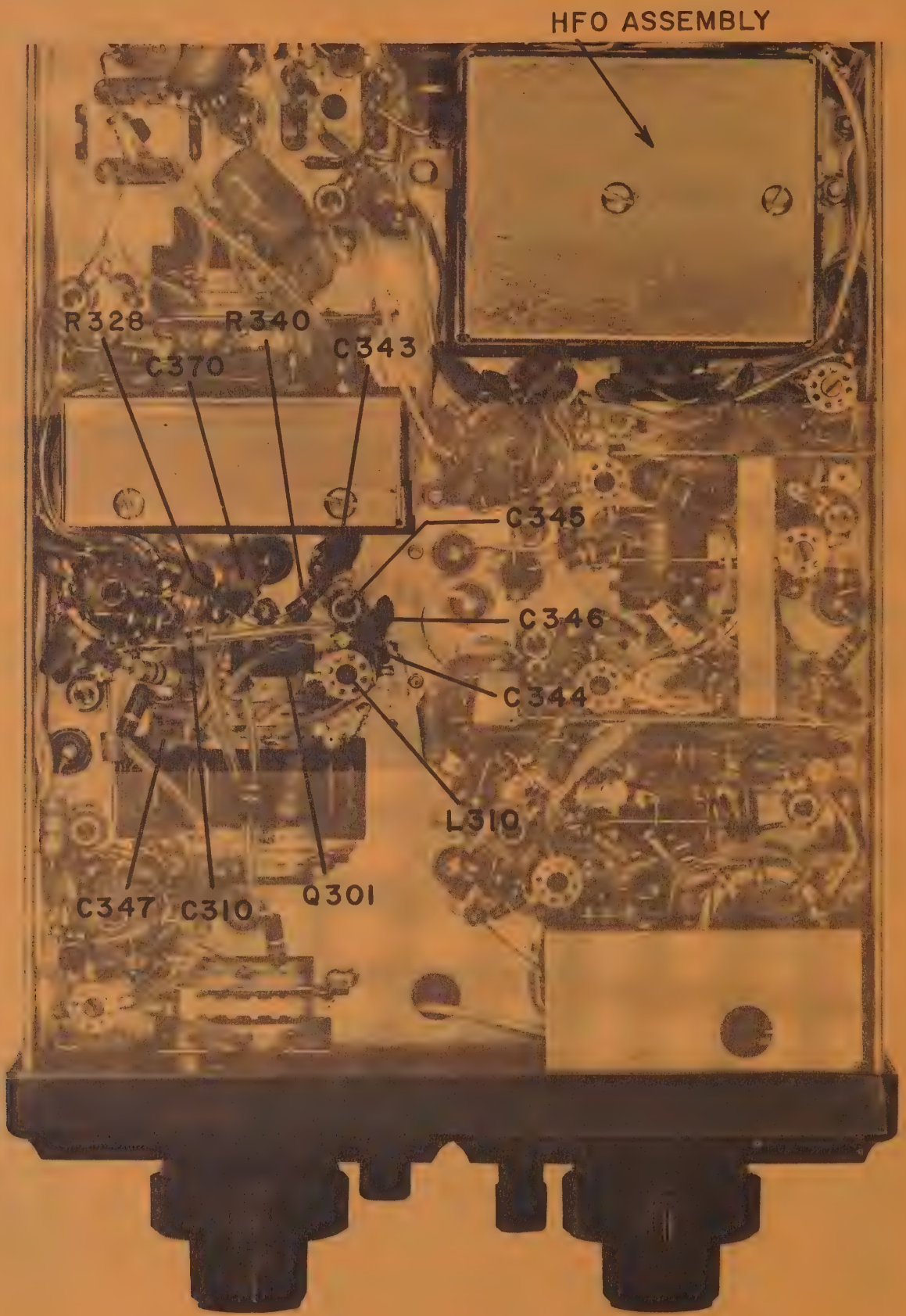


FIGURE L. BEFORE CONVERSION

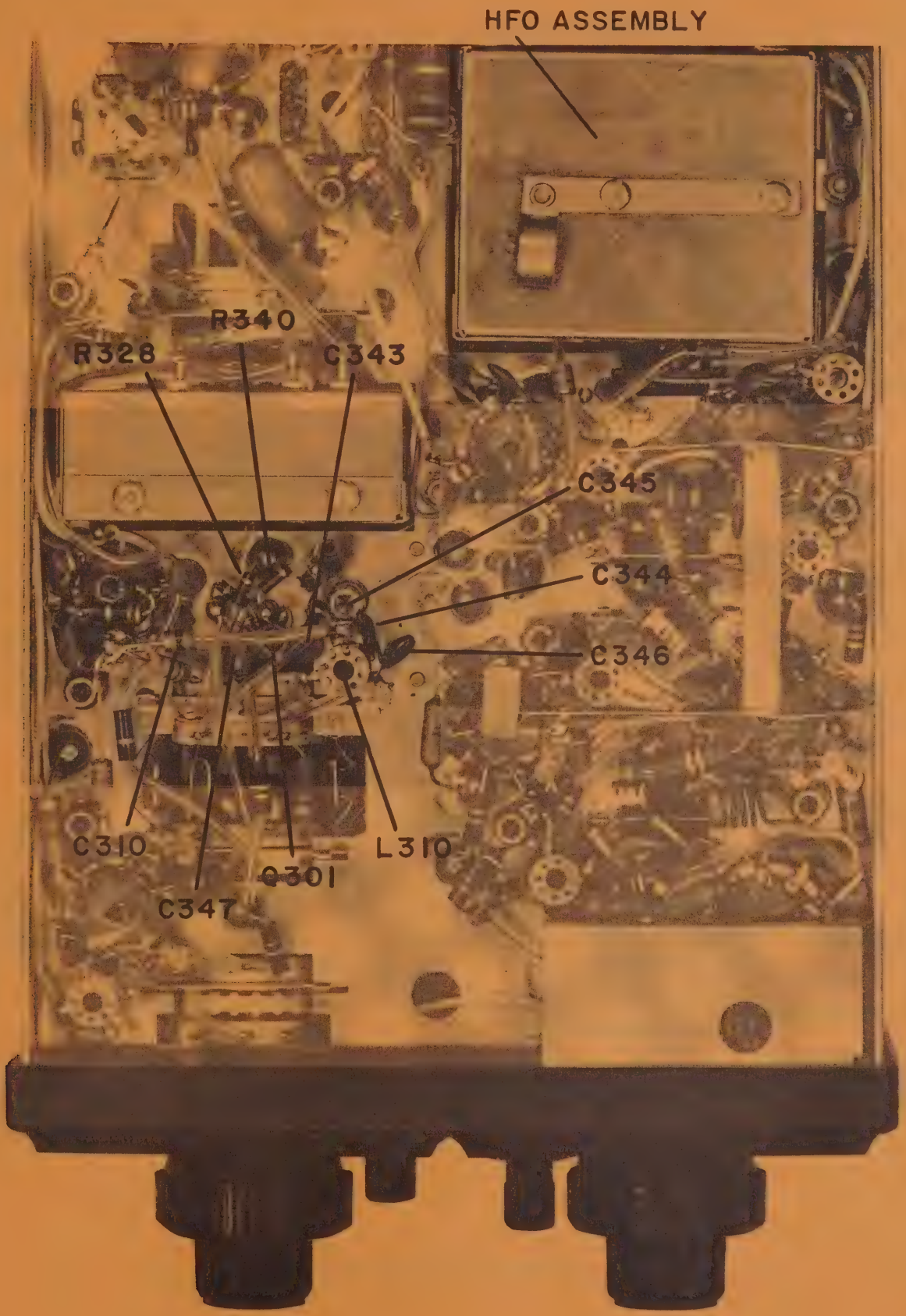
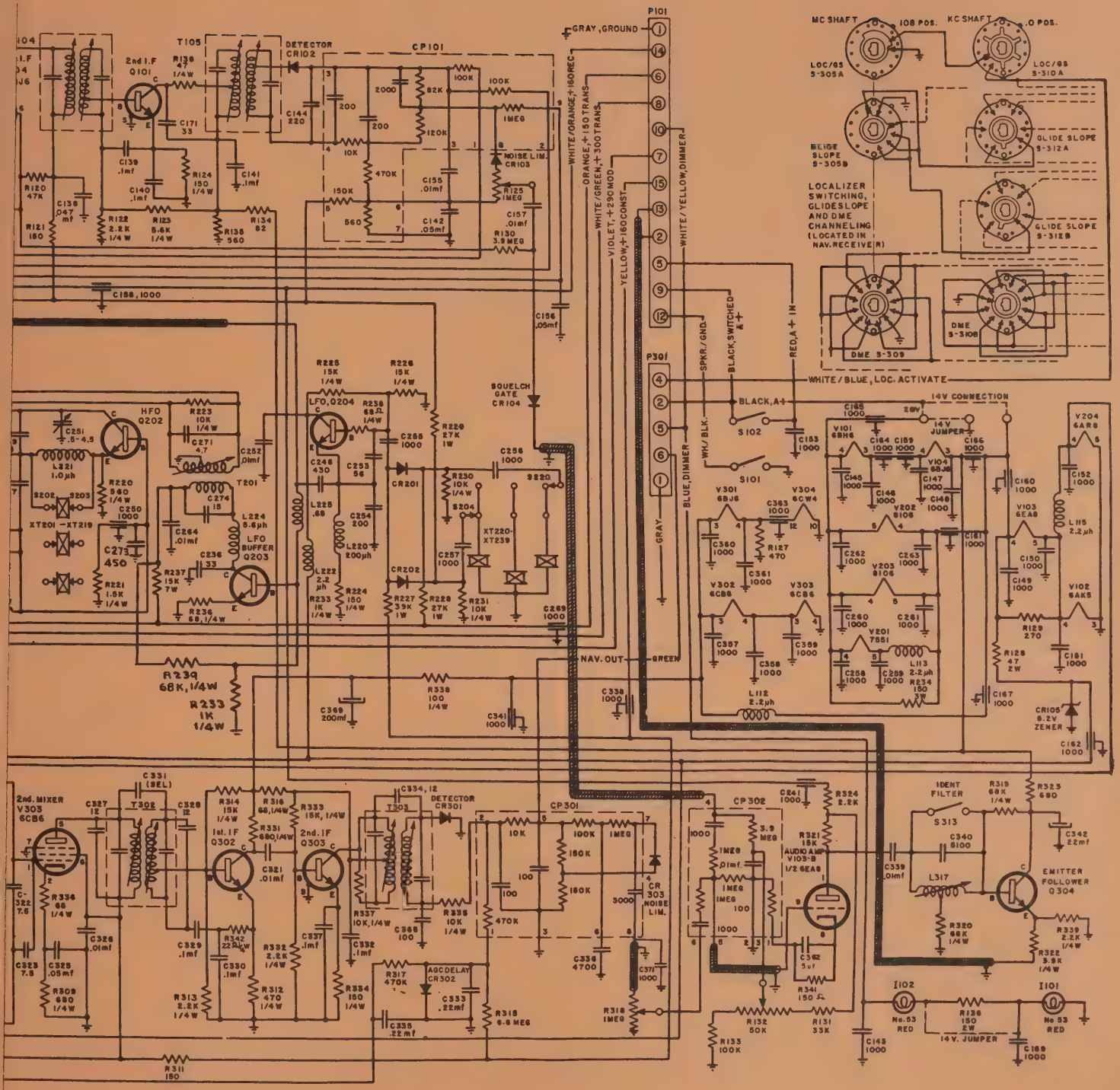
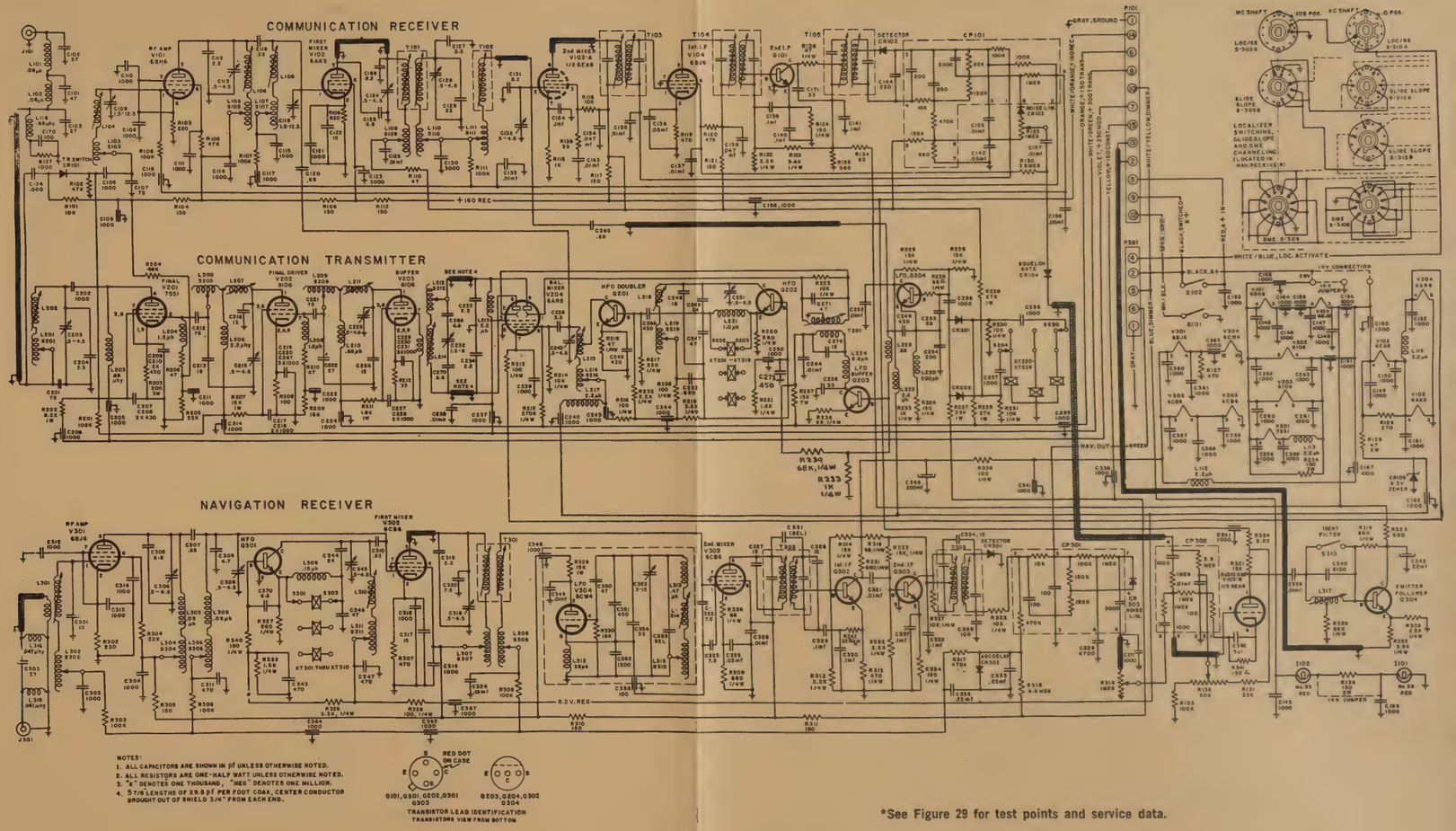


FIGURE M. AFTER CONVERSION



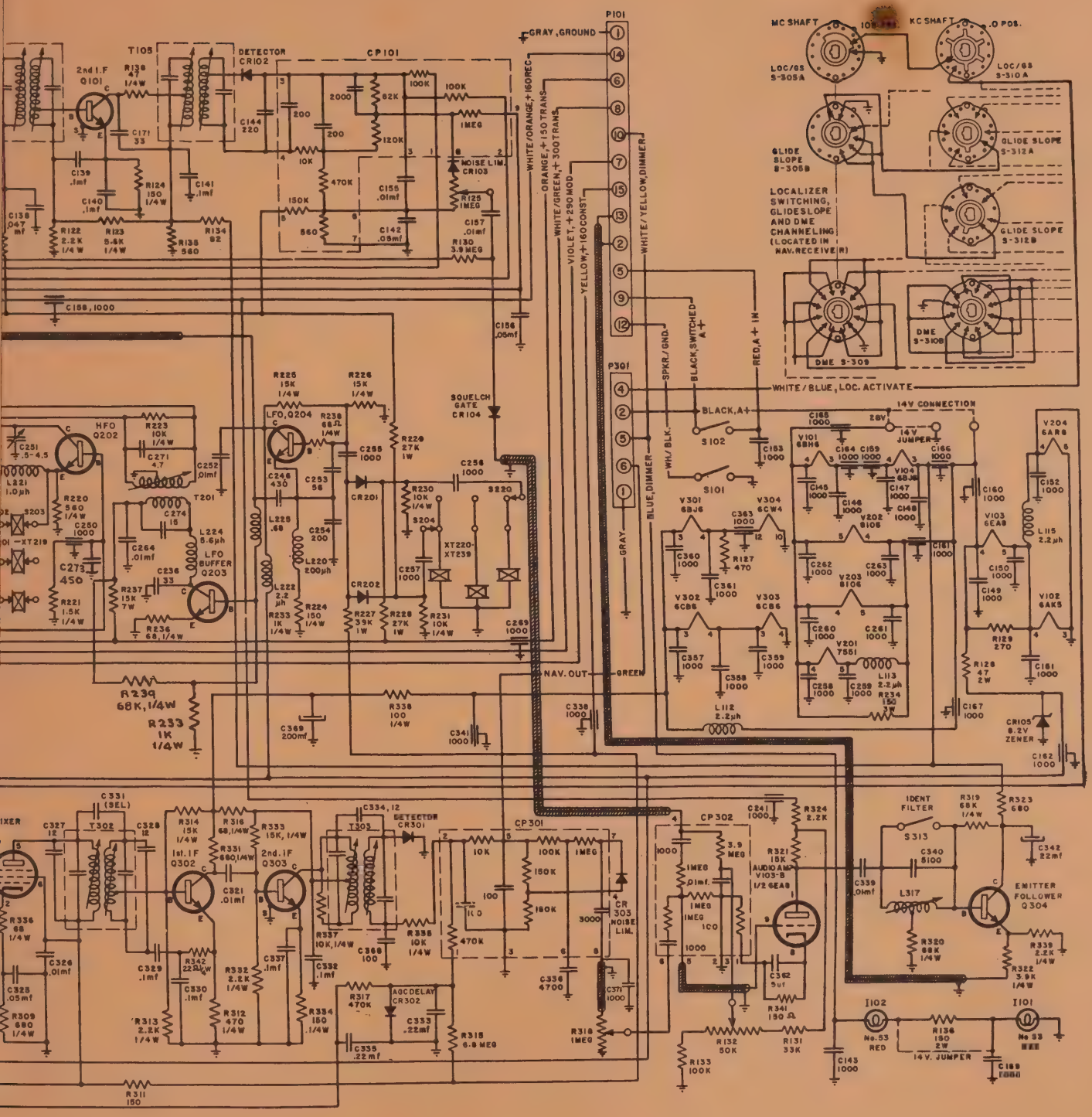
*See Figure 29 for test points and service data.

FIGURE 32. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B1



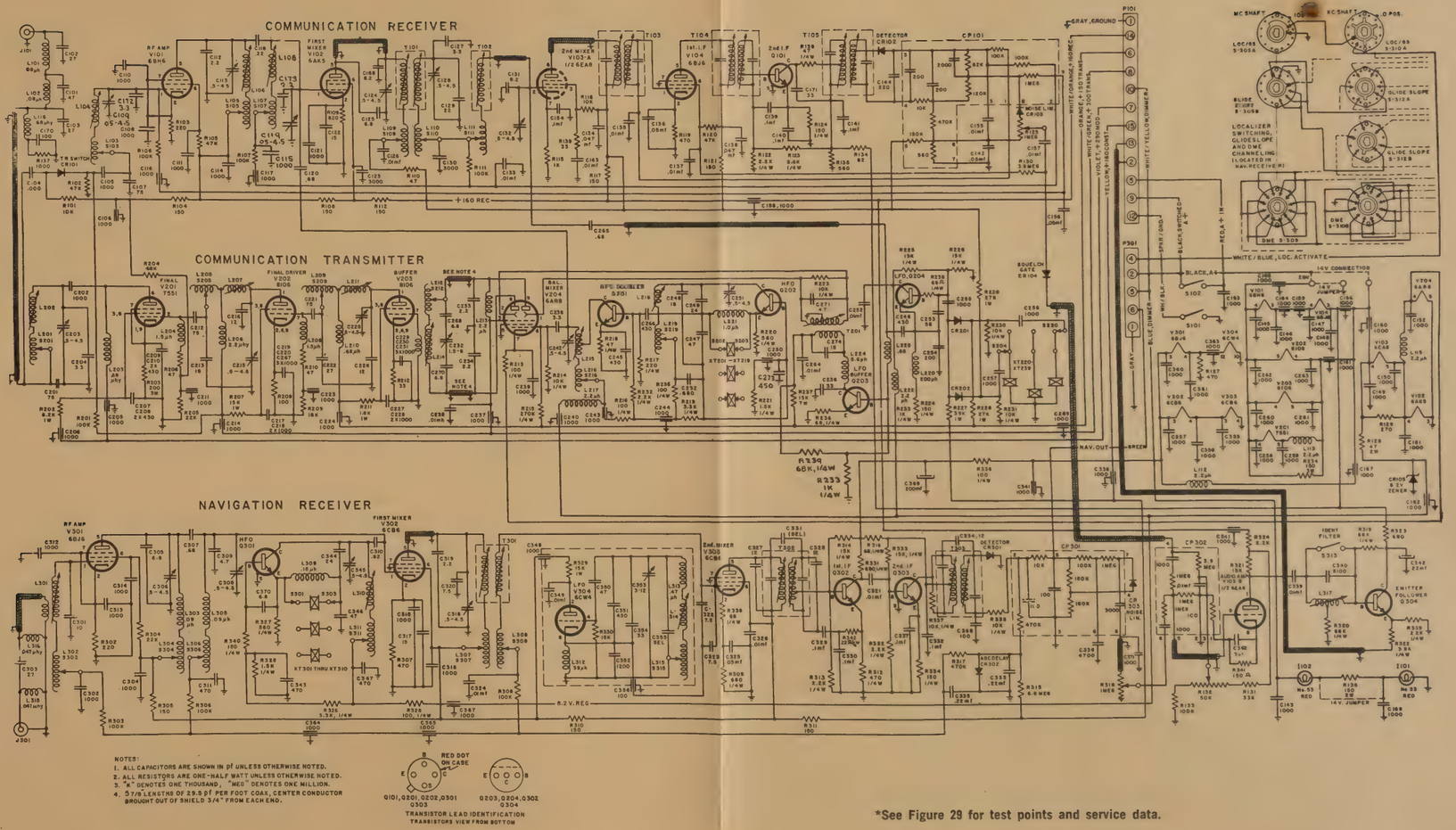
*See Figure 29 for test points and service data.

FIGURE 32. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B1



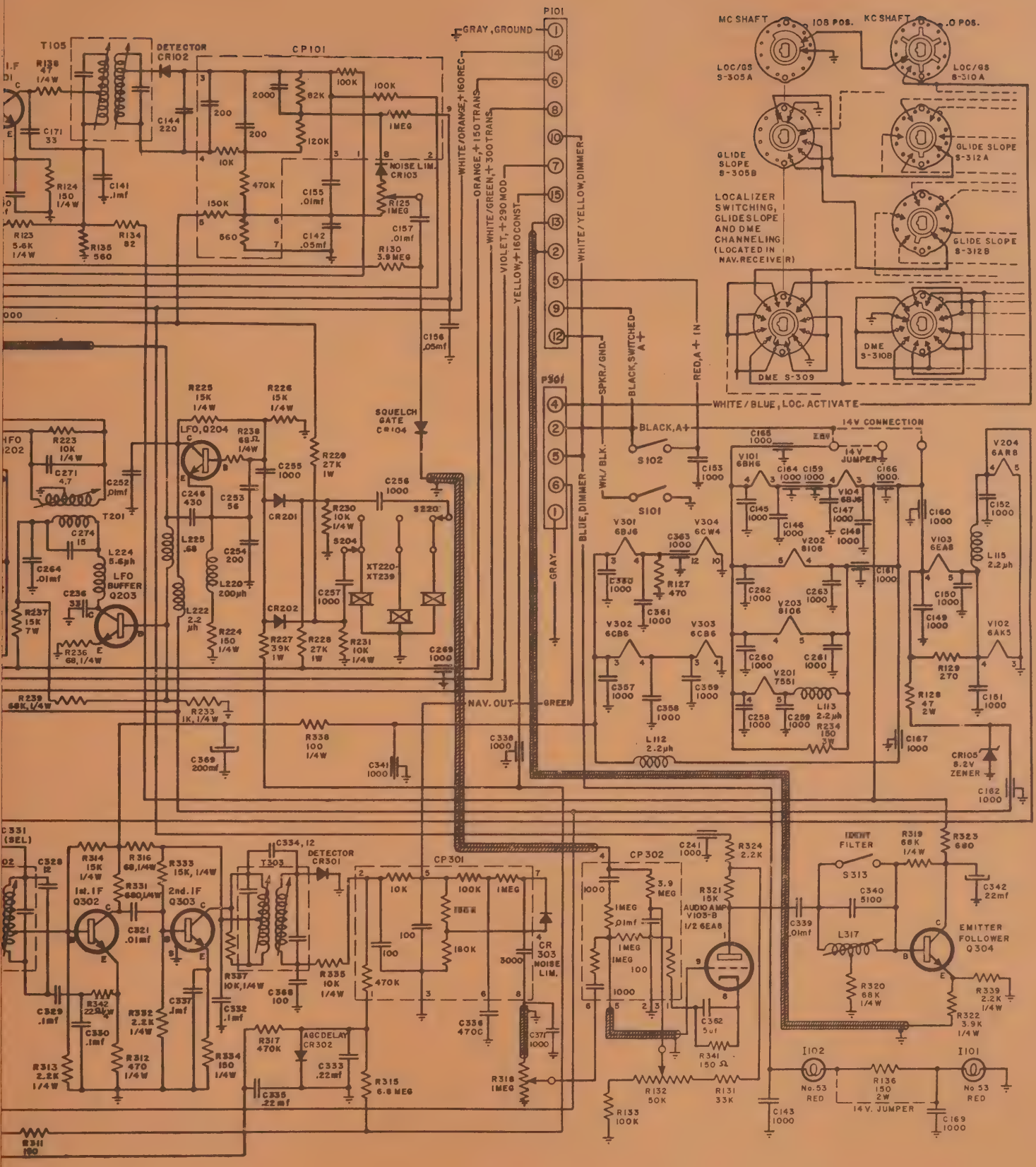
*See Figure 29 for test points and service data.

FIGURE 33. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B2


COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 57/8" LENGTHS OF 29.5 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
RED DOT ON CASE
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

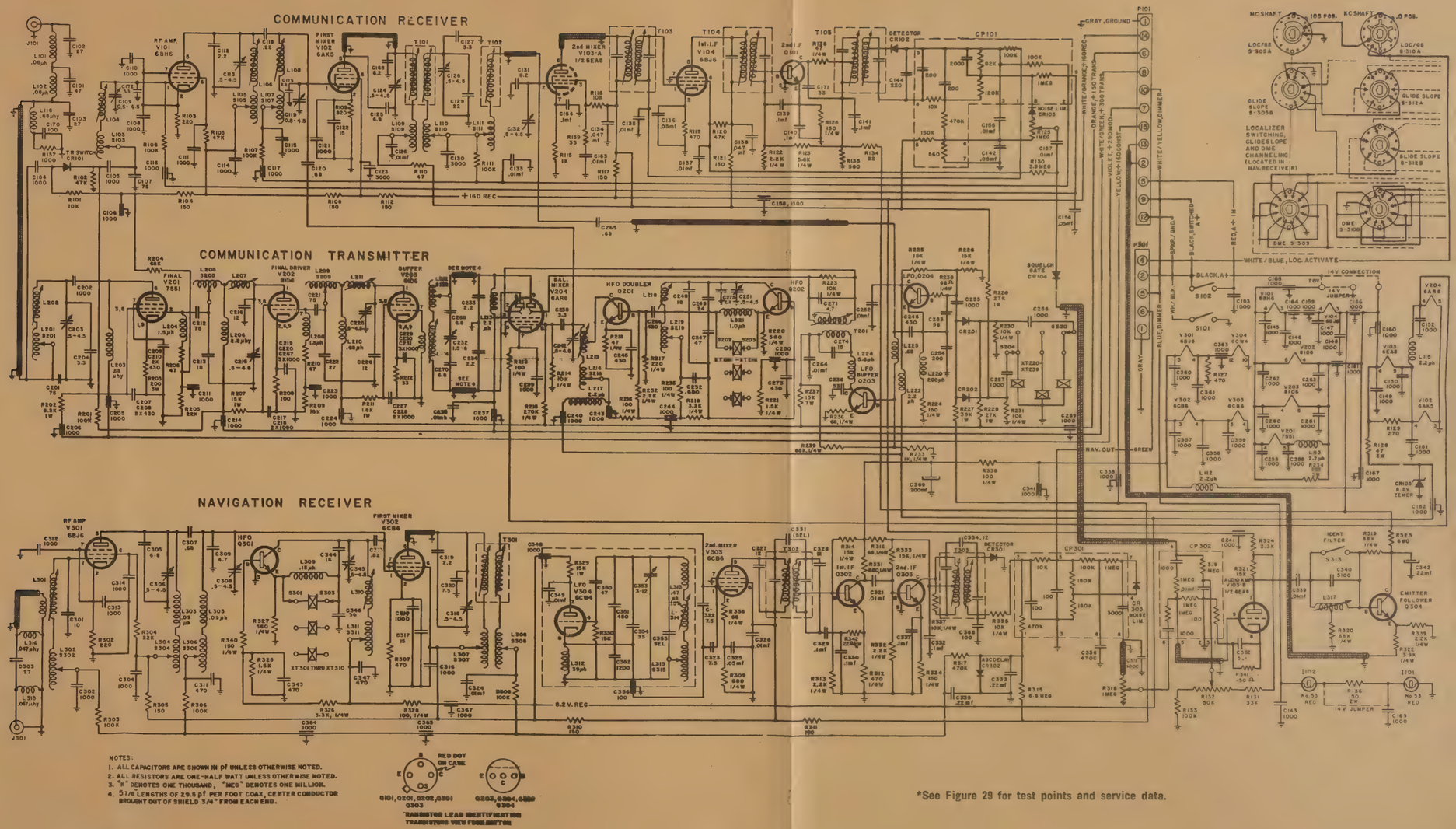
*See Figure 29 for test points and service data.

FIGURE 33. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B2



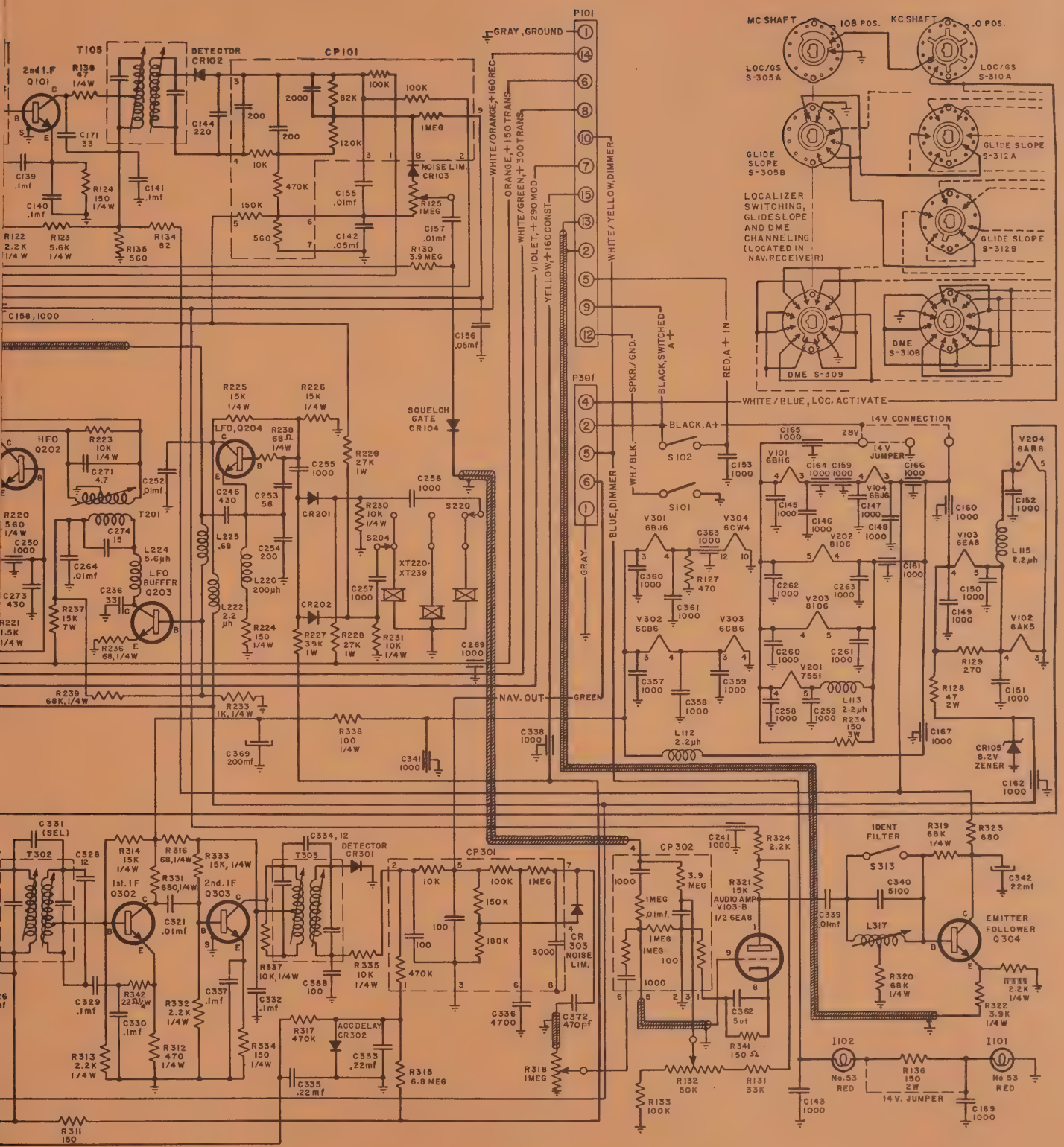
*See Figure 29 for test points and service data.

FIGURE 35. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B4


COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 57/8 LENGTHS OF 29.5 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
RED DOT ON CASE
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM
LOC/GS 9-305A
LOC/GS 9-310A
GLIDE SLOPE 9-305B
GLIDE SLOPE 9-312A
LOCALIZER SWITCHING, GLIDE SLOPE AND DME CHANNELING (LOCATED IN NAV. RECEIVER)
GLIDE SLOPE 9-312B
DME 9-309
DME 9-330B
14V JUMPER
14V CONNECTION

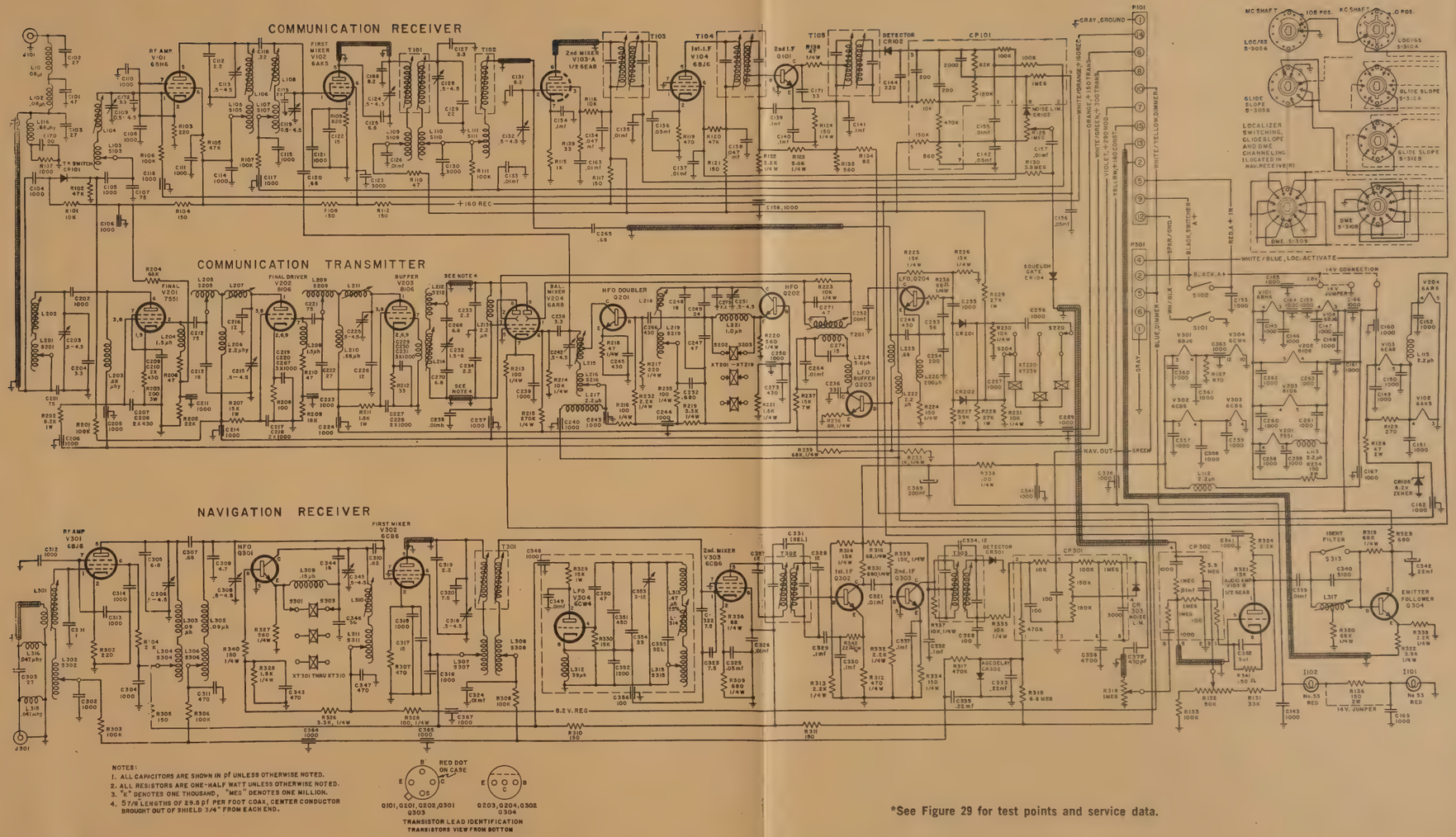
*See Figure 29 for test points and service data.

FIGURE 35. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B4



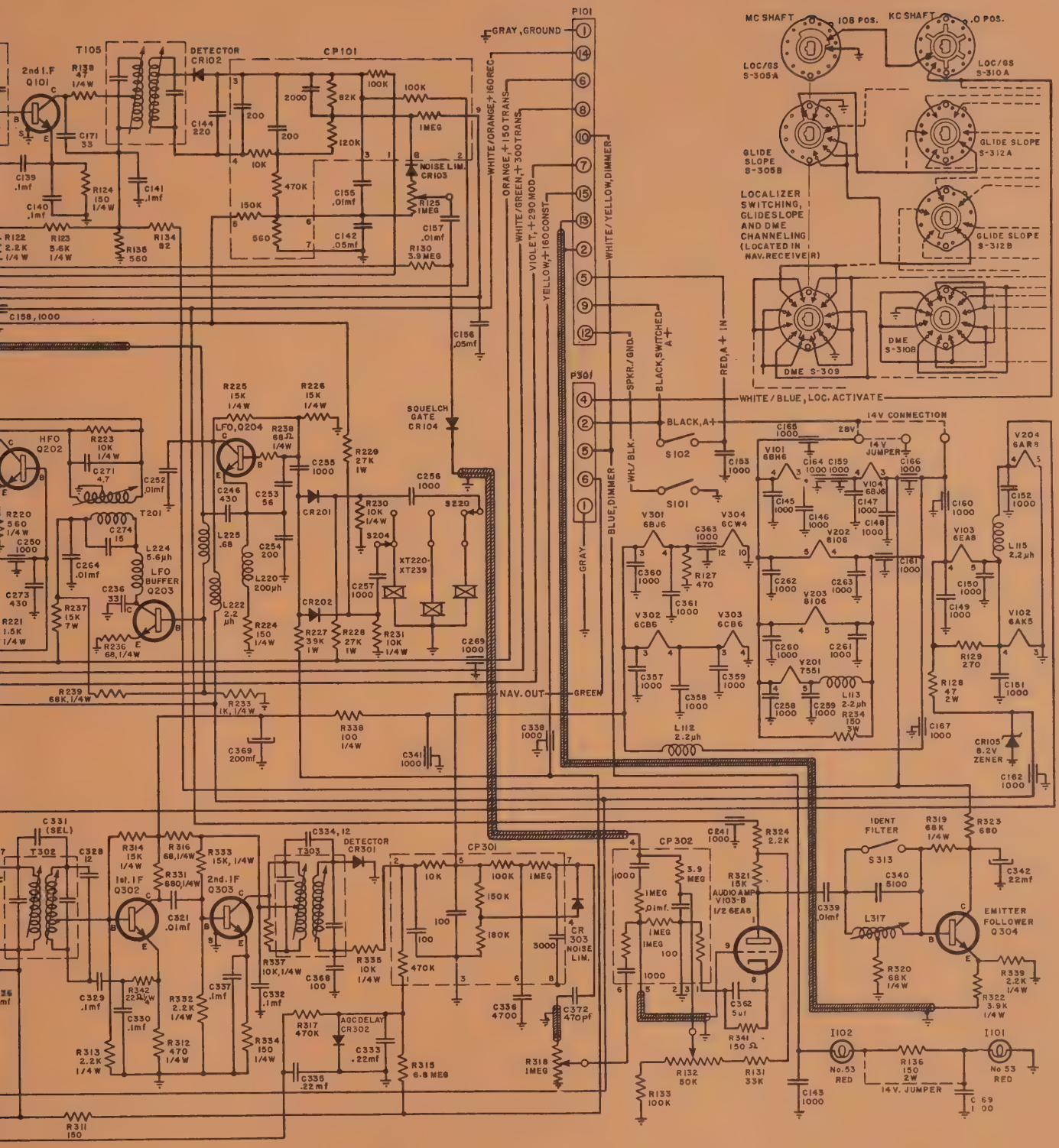
*See Figure 29 for test points and service data.

FIGURE 36. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B5


COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 57/8 LENGTHS OF 29.5 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
RED DOT ON CASE
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

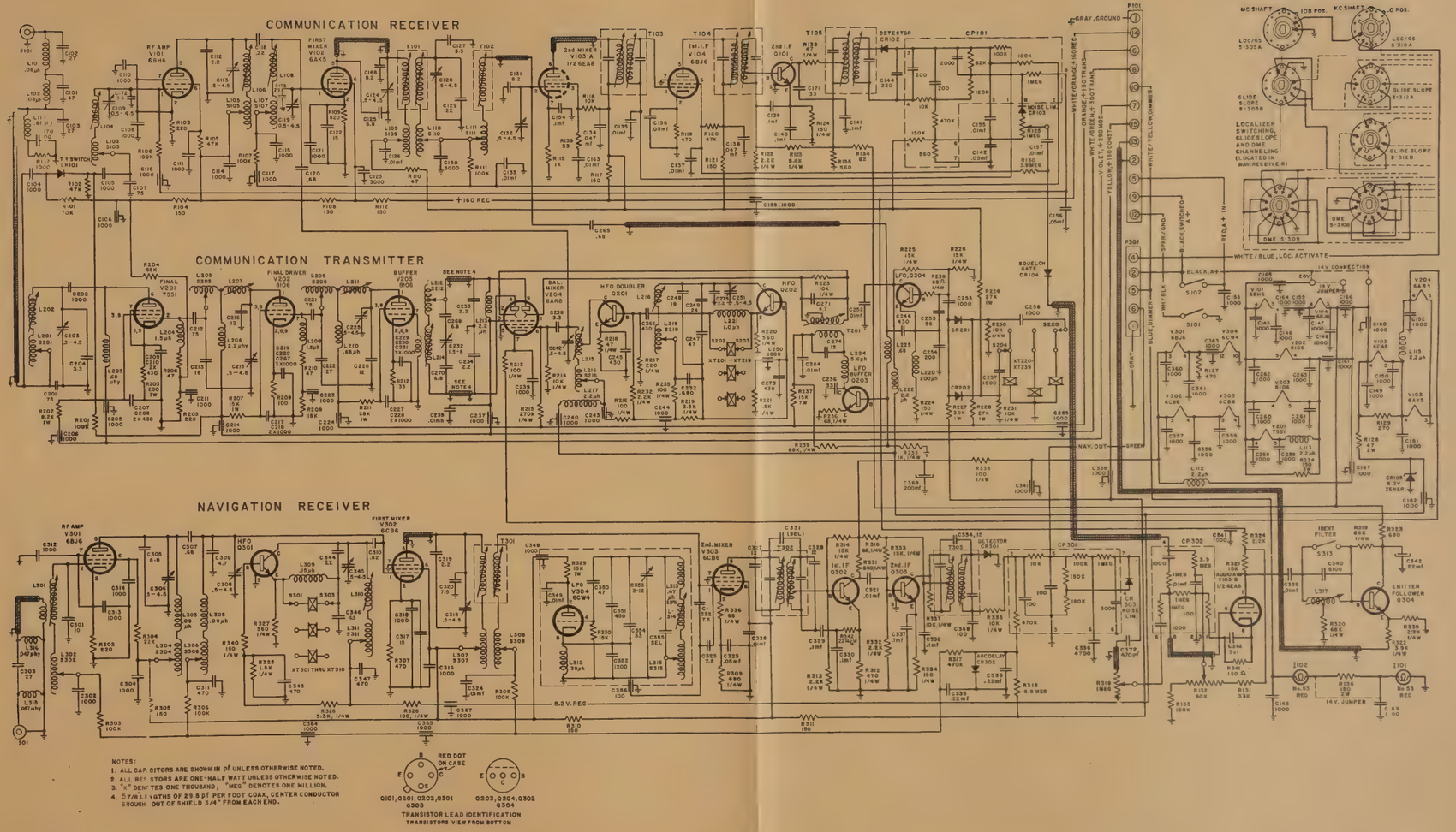
*See Figure 29 for test points and service data.

FIGURE 36. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B5



*See Figure 29 for test points and service data.

FIGURE 37. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B6


COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 5 7/8 LENGTHS OF 29.5 pf PER FOOT COAX, CENTER CONDUCTOR BROUGH OUT OF SHIELD 3/4" FROM EACH END.
RED DOT ON CASE
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

*See Figure 29 for test points and service data.

FIGURE 37. NARCO AVIONICS MARK 12A, SCHEMATIC FOR CN-144-B6

NARCO AVIONICS

SUPPLEMENT 2

Place this sheet at the front of the original manual (MM3077-600) to indicate that the supplement is included in this maintenance manual.

MARK 12A

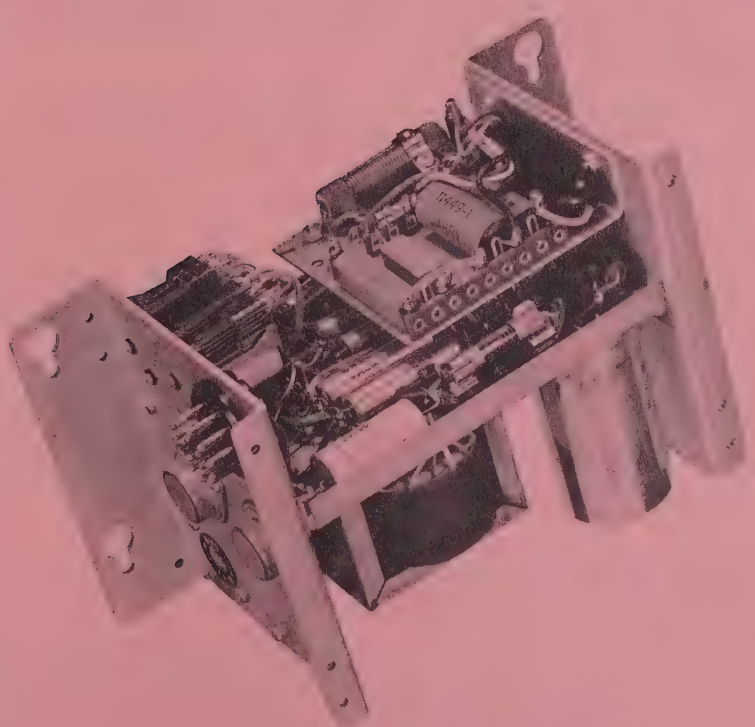
MODULATOR — POWER UNIT

T(12) or T(24)

MP-12A-1 and MP-12AH-1

14/28 VOLT

MAINTENANCE MANUAL



NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
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April, 1968

INTRODUCTION.

The Modulator-Power Units, T (12) or T (24) MP-12A-1 and MP-12AH-1, provide both communication and intercommunication between pilot and co-pilot through a common power amplifier.

The remote-mounted Unit contains the power supply and audio-modulator. An auxiliary audio input circuit is provided so that one or more radio equipments may be connected to operate through the Unit. The audio input circuit is designed for a level of 50 milliwatts from a 300 ohm source.

These Units have been designed to be mounted either horizontally or vertically, by means of the mounting base supplied.

A gain control in the microphone input may be adjusted for full modulation with inputs of .06 to 0.5 volts from a 100 ohm source. This control is preset at the factory for carbon microphone levels.

HELICOPTER APPLICATION.

The suffix "AH" in the Unit's designation indicates that the Unit is for helicopter application.

The "AH" units are designed to be integrated with the cyclic's communication buttons.

Most helicoptors, due to noise levels, require the use of headphones and boom mikes. It is for this reason that the cyclic is provided with two communication buttons: (1) a comm switch, (2) an intercomm switch.

K-502, R-414, and C-509 in the "AH" Units provide delay in switching, eliminating the click in the headphones caused by the collapsing field in the Power Unit output transformer. The side-tone level has been adjusted with proper modulation level for listening comfort during transmission. Figure 38, illustrates the intercom circuit.

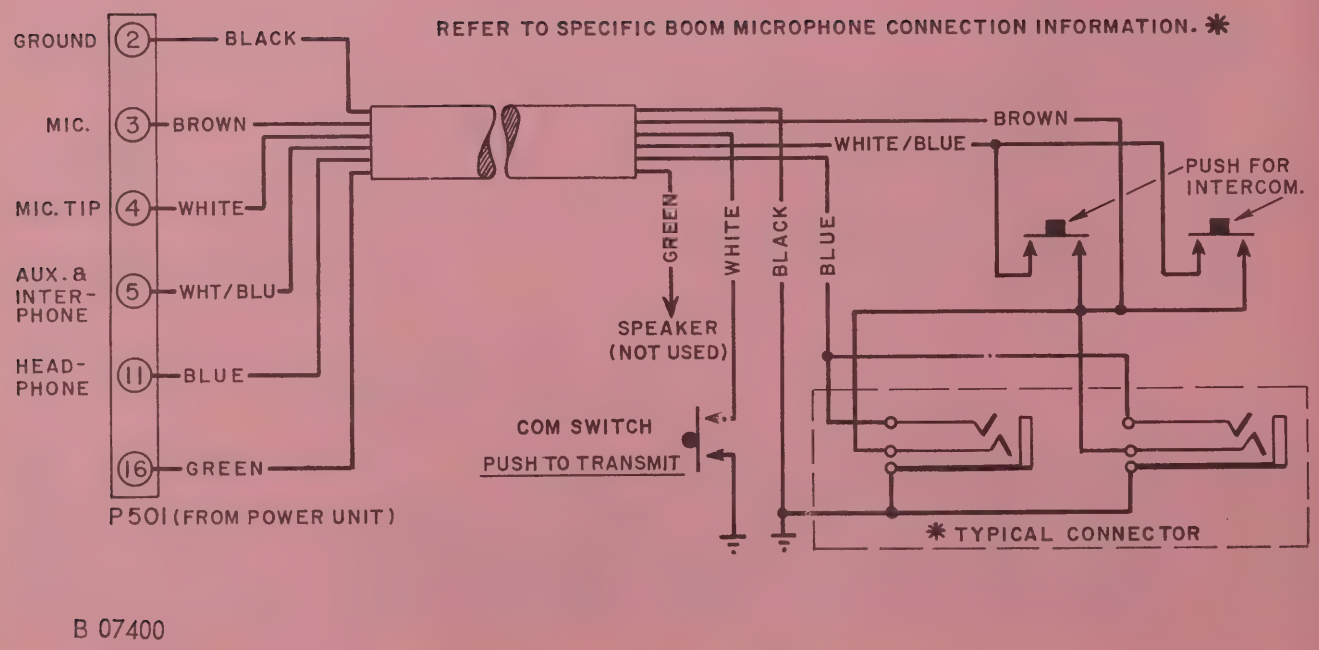


FIGURE 38. T (12/24) MP-12AH-1 WIRING DIAGRAM

CIRCUIT DESCRIPTION.

Power Circuits (Modulator-Power Unit)

The power supply section uses two power transistors, Q-501 and Q-502, and a power transformer, T-501, in a circuit whose simplified operation is as follows. The instant primary voltage is applied (A+), because of the inevitable dissimilarity of the two transistors more current will flow in one than in the other. This greater flow of current through the feedback windings of the power transformer induces a voltage on the transistors such that the conducting unit is driven into greater conduction and the other is held at cut-off.

Almost instantly the transformer reaches saturation. Thus having reached maximum flux density, there is no more induced voltage in the bias windings which are connected to the transistor circuitry. Therefore, the current through the conducting transistor decreases, and bias voltage at opposite polarity is developed which cuts off this transistor and simultaneously causes the second transistor to conduct. The same procedure repeats with the second transistor. This switching action repeats at high speed and the resultant output voltage of T-501 is essentially a square wave.

A full wave bridge rectifier consisting of CR-501, CR-502, CR-503, and CR-504 in conjunction with the center tapped secondary of T-501 provides a simple means of obtaining a dual voltage output. Filtering of these DC voltages is easily accomplished because of the high frequency of the power supply.

Panel Unit Audio Circuits.

Audio signals from the two volume controls are combined in CP-302, then applied to the grid of the first audio amplifier, V-103-B. The amplified audio signal at the plate of V-103-B is applied to the base of Q-304 through a parallel tuned filter consisting of C-340 and L-317. This filter is tuned to 1020 cps. It presents a high impedance at this frequency to provide approximately 20 db rejection of the code identification tone transmitted by navigation stations. S-313, the push-pull switch attached to the NAV volume control, shorts out the filter when pulled. This permits the pilot to hear the code identification. When the knob is pushed in the tone is reduced to make voice transmissions more understandable. Q-304 is an emitter follower providing an impedance match to the audio power amplifier.

Audio Circuits ("A-1" Series).

The remainder of the audio circuit is located in the modulator/power unit. In the receive mode, the audio signal from Q-304 is switched by K-501 to the base of Q-401, the audio driver. The audio output is switched by K-501 to the speaker output lead, and is applied at all times to the headphone lead.

In the transmit mode, audio signal from the microphone is switched by K-501 to the base of Q-401. Audio output is taken from the modulation winding of T-402. In this case, K-501 switches B+ to the modulation winding to activate the transmitter.

Audio Circuits (AH-1 Series).

The audio circuits in the Modulator-Power Unit contains an additional time delay relay (K-502), incorporated in the speaker and phone output leads. The remainder of the circuit is unchanged.

In the transmit mode, relay K-503 activates relay K-502 and capacitor C-509, (which is across relay K-502s windings) begins to charge. When the transmitter is un-keyed, the charge on C-509 keeps K-502 closed for approximately 20 milliseconds, allowing the inductive kickback of the audio output transformer modulation secondary (T-402) to bleed off, thus preventing a loud unpleasant noise in the phones or speaker. Resistor R-413 is wired across contacts 3 and 5 of relay K-502 so that in the transmit mode, a headphone sidetone signal is provided.

MAINTENANCE SERVICE PROCEDURE MODULATOR-POWER UNIT.

The only control requiring adjustment is the microphone a gain control. It is adjusted at the factory for normal carbon microphones, and should need adjustment only if the MK-12A is to be used with a microphone providing a higher output level. If adjustment is required, proceed as follows:

Recommended Method (Bench Adjustment).

Connect the Unit to a primary power source. Connect the microphone to the modulator/power and accessory cable. Connect an oscilloscope to C-205 (feed-thru capacitor in left front corner of chassis.)

Connect a 50 ohm, 10 watt, dummy load to the COM antenna jack. If possible, have the pilot speak into the microphone in his normal manner. Turn the gain control fully counterclockwise. Key transmitter and, while speaking into the microphone, adjust the gain control until the positive and negative voice peaks, viewed on the oscilloscope, begin flattening.

Alternate Method (Adjustment in Aircraft).

Connect the microphone to the Mark 12A. Connect the common lead to a Simpson Model 260 VOM, or equivalent, to the Mark 12A chassis. Connect the probe to C-205, (feedthru capacitor in left front corner of the chassis). Set the VOM function selector to "output." Key the transmitter, and while speaking a sustained "ah" into the microphone, adjust the gain control for a reading of 60 to 75 volts on the VOM.

REPLACEMENT PARTS LIST

This Replacement Parts List provides a listing of all the replaceable parts of the Modulator-Power Units MP-12A-1 and MP-12AH-1 both 14 and 28 volts.

Due to the similarity between Units, all Units have been combined into one list. The Used On Column indicates which Unit the particular part is used on. When ALL is indicated, it means that the part is common to all the units described in the list heading. See figures 39 thru 42 for part location.

Modulator-Power Unit		Used On	See Figure
T (12) MP-12-A1	14V	A	39
T (24) MP-12-A1	28V	B	40
T (12) MP-12-AH-1	14V	C	41
T (24) MP-12-AH-1	28V	D	42

Item or Symbol No.	Narco Part No.	Description	Used On
		Mechanical Parts	
1	04238-9	Label, T(12)MP12A-1	A
1	04238-10	Label, T(24)MP12A-1	B
1	04238-11	Label, T(12)MP-12AH-1	C
1	04238-12	Label, T(24)MP-12AH-1	D
2	04139-3	Label, Warning	ALL
3	04284-1	Label, Mike Adjustment	ALL
4	56438-1	Cover, Dust (not shown)	ALL
5	56492-1	Chassis	ALL
6	56491-1	Panel, Front	ALL
7	56438-1	Panel, Rear	ALL
8	55020-2	Insulator, Transistor	ALL
9	56490-1	Shelf	ALL
10	81213-6	Spacer, Trans. Mount	ALL
11	81440-5	Tie Lug Strip, 10 Lug	ALL
12	81442-10	Tie Lung Strip, 6 Lug	ALL
13	81436-6	Tie Lug Strip, 9 Lug	ALL
14	81335-11	Insulator, Shoulder	ALL
15	81443-1	Tie Lug Strip, 5 Lug	ALL
16	81435-13	Tie Lug Strip, 8 Lug	ALL
17	81436-5	Tie Lug Strip, 9 Lug	ALL
18	81436-9	Tie Lug Strip, 9 Lug	ALL
19	66507-1	Fuseholder	ALL
20	82010-20	Clamp, Cable	ALL
21	56489-1	Bar, Pot Ganging	ALL
22	81213-65	Spacer, Pot Mounting	ALL
23	81213-64	Spacer, Sub-chassis	ALL

Item or Symbol No.	Narco Part No.	Description	Used on
		Electrical Parts	
C-401	21554-3	CAPACITOR, ELECTROLYTIC, 200 mfd, 15V	ALL
C-405	23078-273	CAPACTOR, MYLAR, .027 mfd ±5%, 1000V	ALL
C-406	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	ALL
C-408	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	C, D
C-501	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	ALL
C-502	21556-1	CAPACITOR, ELECTROLYTIC, 40 mfd, 475V, 100 mfd, 250V, 20 mfd, 250V	ALL
C-505	23086-19	CAPACITOR, MYLAR, 2.0 mfd, 200V	ALL
C-506	21525-29	CAPACITOR, ELECTROLYTIC, 500 mfd, 35V	ALL
C-509	21554-3	CAPACITOR, ELECTROLYTIC, 200 mfd, 15V	C, D
CR-501	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-502	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-503	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-504	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-505	75204-45	DIODE, SILICON, 500 PIV	ALL
F-501	66504-12	FUSE, SLO/BLO, 10 amp	A, C
F-501	66504-10	FUSE, SLO/BLO, 6¼ amp	B, D
J-501	41181-4	CONNECTOR, PLUG, 16 pin	ALL
K-501	65126-23	RELAY	A, B
K-502	65134-1	RELAY	C, D
K-503	65134-2	RELAY	C, D
L-401	11814-3	INDUCTOR, FILTER	ALL
L-501	11449-1	CHOKE, 50 μh	ALL
Q-401	75571-2	TRANSISTOR, DRIVER	ALL
Q-402	75534-3	TRANSISTOR, AUDIO, OUTPUT	A, C
Q-402	75544-2	TRANSISTOR, AUDIO, OUTPUT	B, D
Q-403	75534-3	TRANSISTOR, AUDIO, OUTPUT	A, C
Q-403	75544-2	TRANSISTOR, AUDIO, OUTPUT	B, D
Q-501	75564-2	TRANSISTOR, POWER	ALL
Q-502	75564-2	TRANSISTOR, POWER	ALL
R-401	31141-103	RESISTOR, FIXED, COMPOSITION, 10K ±10%, ½W	ALL
R-402	31141-472	RESISTOR, FIXED, COMPOSITIOIN, 4.7K ±10%, ½W	ALL
R-403	31187-1	RESISTOR, TEMPERATURE, SENSITIVE, 0.24 ohm ±10%, +T.C.	A, C
R-403	31179-1	RESISTOR, TEMPERATURE, SENSITIVE, 0.47 ohm ±10%, +T.C.	B, D
R-404	31141-471	RESISTOR, FIXED,COMPOSITION, 470 ohm ±10%, ½W	ALL
R-405	31141-689	RESISTOR, FIXED, COMPOSITION, 6.8 ohm ±10%, ½W	A, C
R-405	31141-829	RESISTOR, FIXED, COMPOSITION, 8.2 ohm ±10%, ½W	B, D
R-406	31136-103	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 2W	ALL
R-408	31141-822	RESISTOR, FIXED, COMPOSITION, 8.2K ±10%, ½W	A, B
R-408	31141-471	RESISTOR, FIXED, COMPOSITION, 470 ohm ±10%, ½W	C, D
R-409	31175-11	RESISTOR, WIREWOUND, 75 ohm ±5%, 5W	B, D
R-410	32045-13	RESISTOR, VARIABLE, Wirewound, 200 ohm, 2W	ALL
R-411	32045-13	RESISTOR, VARIABLE, Wirewound, 200 ohm, 2W	ALL
R-412	31175-22	RESISTOR, WIREWOUND, 1K ohm ±10%, 5W	ALL
R-413	31141-332	RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, ½W	C, D
R-414	31141-220	RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, ½W	C, D
R-415	31141-100	RESISTOR, FIXED, COMPOSITION, 10 ohm ±10%, ½W	A, C
R-415	31141-180	RESISTOR, FIXED, COMPOSITION, 18 ohm ±10%, ½W	B, D
R-416	31141-102	RESISTOR, FIXED, COMPOSITION, 1K ±10%, ½W	A, C
R-416	31141-331	RESISTOR, FIXED, COMPOSITION, 330 ohm ±10%, ½W	B, D
R-417	33002-109	RESISTOR, WIRE ADJUSTABLE, 1 ohm, 10W	A, C
R-417	33002-309	RESISTOR, WIRE ADJUSTABLE, 3 ohm, 10W	B, D
R-418	31141-102	RESISTOR, FIXED, COMPOSITION, 1K ±10%, ½W	ALL
R-501	31136-471	RESISTOR, FIXED, COMPOSITION, 470 ohm ±10%, 2W	ALL
R-502	31175-24	RESISTOR, WIREWOUND, 10 ohm ±10%, 7W	A, C
R-502	31136-220	RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, 2W	B, D
R-503	31141-229	RESISTOR, FIXED, COMPOSITION, 2.2 ohm ±10%, ½W	A, C
R-505	31135-274	RESISTOR, FIXED, COMPOSITION, 270K ±10%, 1W	ALL
R-506	31136-101	RESISTOR, FIXED, COMPOSITION, 100 ohm ±10%, 2W	ALL
R-507	31175-11	RESISTOR, WIREWOUND, 75 ohm ±5%, 5W	B
R-511	31157-6	RESISTOR, WIREWOUND, 42 ohm ±5%, 7W	D
T-401	11706-2	TRANSFORMER, AUDIO, Transistor Driver	ALL
T-402	11704-2	TRANSFORMER, AUDIO, OUTPUT, 14 Volt	A, C
T-402	11705-2	TRANSFORMER, AUDIO OUTPUT, 28 Volt	B, D
T-501	11697-1	TRANSFORMER, POWER, 14 Volt	A, C
T-501	11698-1	TRANSFORMER, POWER, 28 Volt	B, D

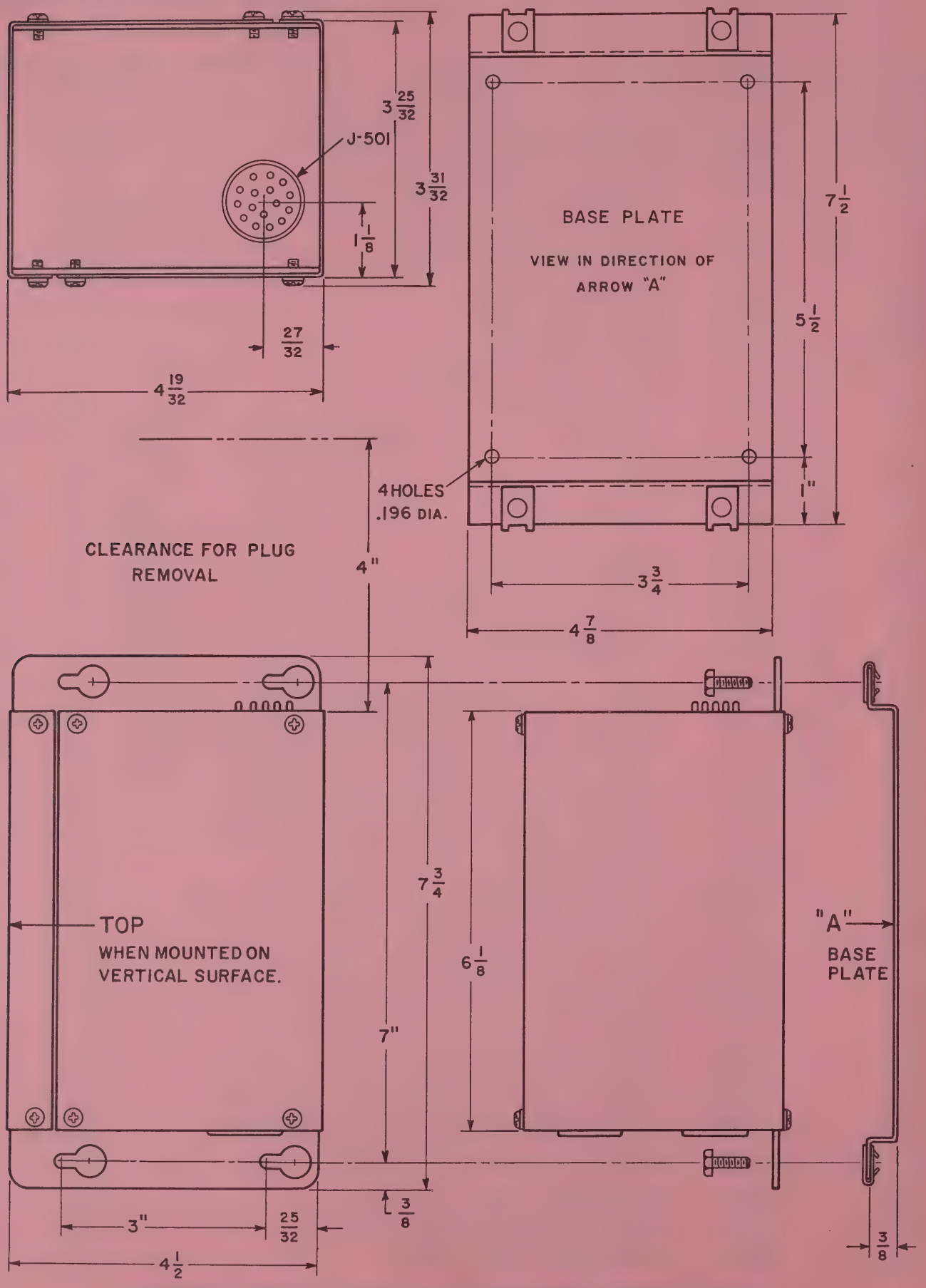
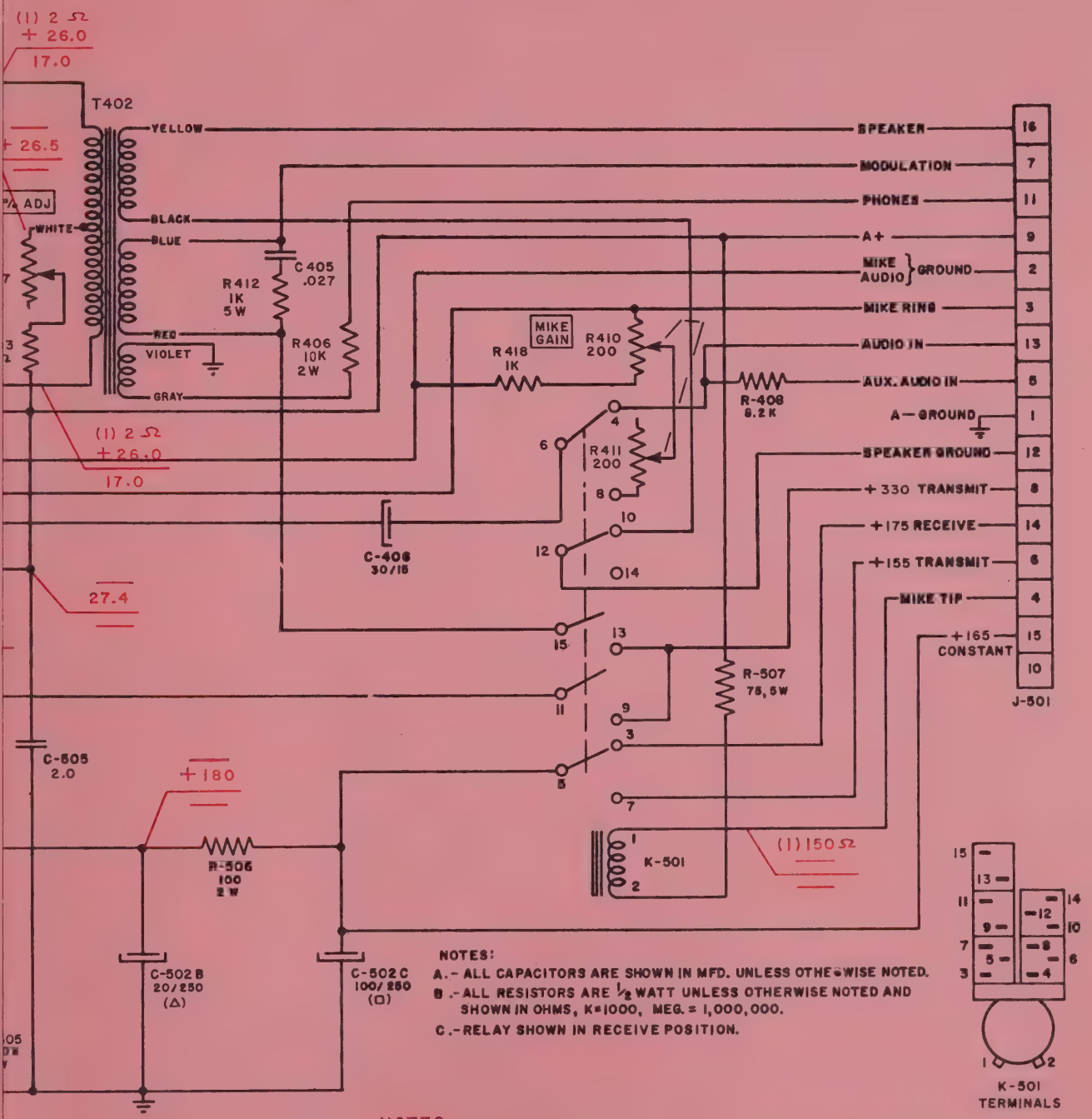


FIGURE 38A. MODULATOR-POWER UNIT INSTALLATION DRAWING (TYPICAL)



NOTES:

A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.

B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG. = 1,000,000.

C.- RELAY SHOWN IN RECEIVE POSITION.

TEST DATA

DC RESISTANCE

DC VOLTAGE & POLARITY

AC VOLTAGE OR WAVESHAPE & P-P VOLTAGE

NOTES:

1. RESISTANCE READINGS MEASURED WITH CABLE CONVECTOR REMOVED FROM J-501
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 27.5 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000 Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE VTVM OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

FIGURE 40. MODULATOR-POWER UNIT, T (24) MP-12A-1
(Drawing and Schematic)

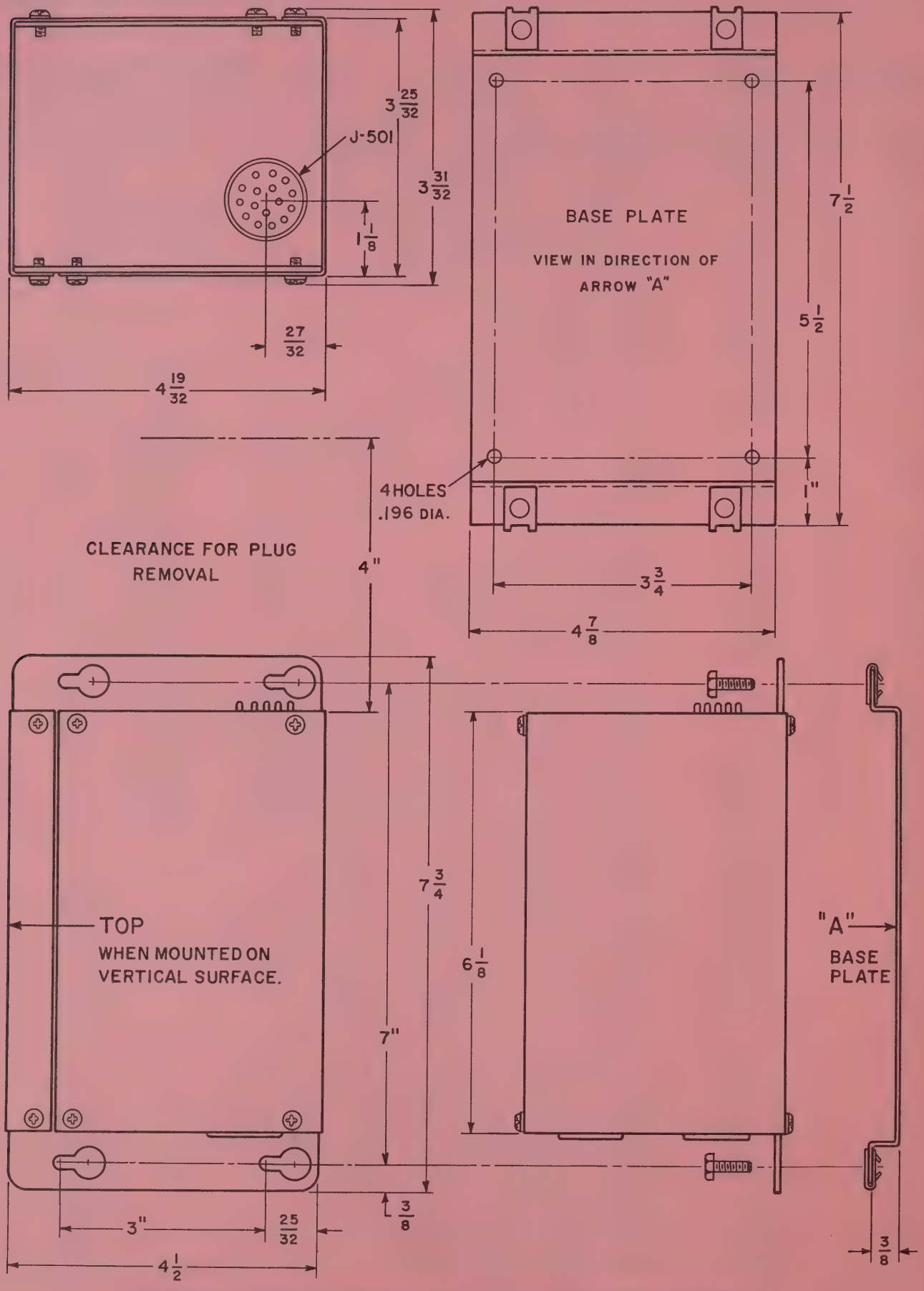
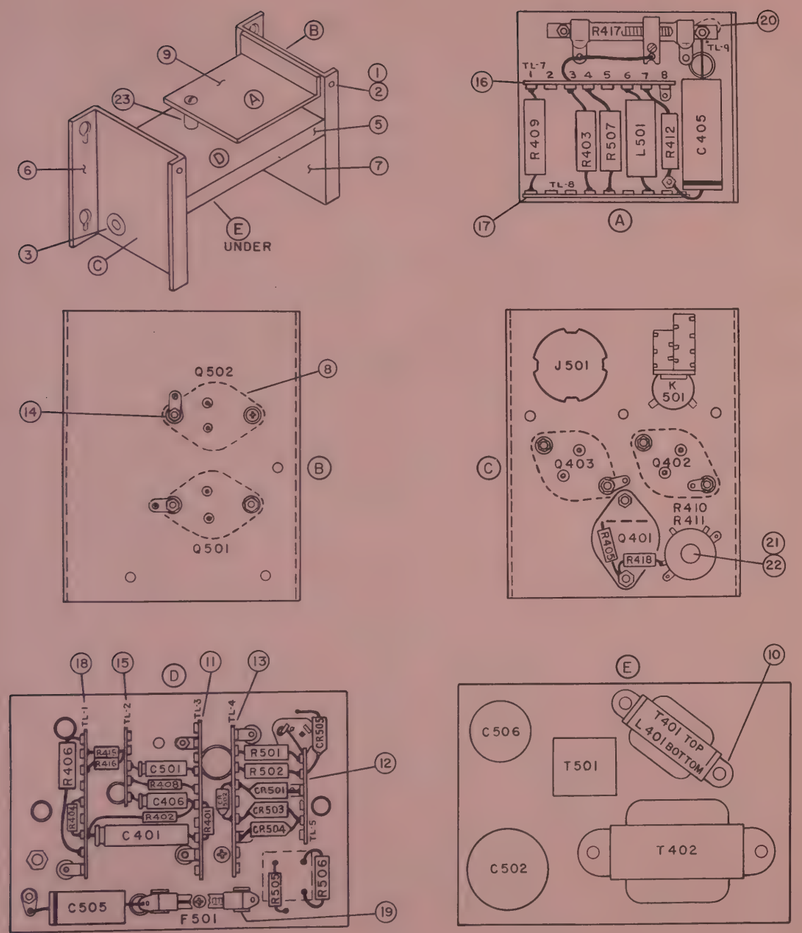
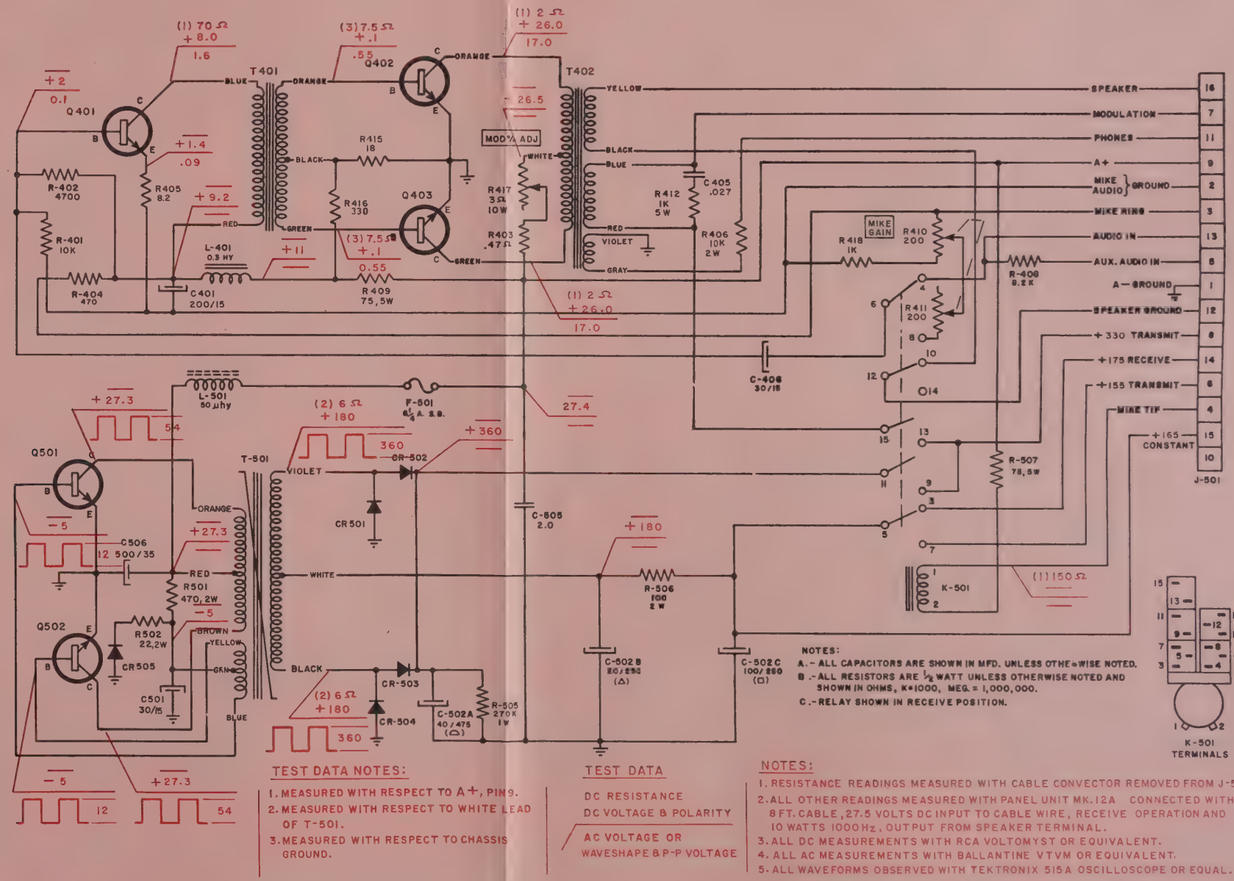


FIGURE 38A. MODULATOR-POWER UNIT INSTALLATION DRAWING (TYPICAL)



PARTS LOCATION DRAWING



NOTES:
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.
C.- RELAY SHOWN IN RECEIVE POSITION.

TEST DATA NOTES:
1. MEASURED WITH RESPECT TO A+, PIN 9.
2. MEASURED WITH RESPECT TO WHITE LEAD OF T-501.
3. MEASURED WITH RESPECT TO CHASSIS GROUND.

TEST DATA
DC RESISTANCE
DC VOLTAGE & POLARITY
AC VOLTAGE OR WAVESHAPE & P-P VOLTAGE

NOTES:
1. RESISTANCE READINGS MEASURED WITH CABLE CONVECTOR REMOVED FROM J-501
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 27.5 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000 Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE VTVM OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

FIGURE 40. MODULATOR-POWER UNIT, T(24) MP-12A-1
(Drawing and Schematic)

TEST POINTS

See Fig. 39 for test points and values.

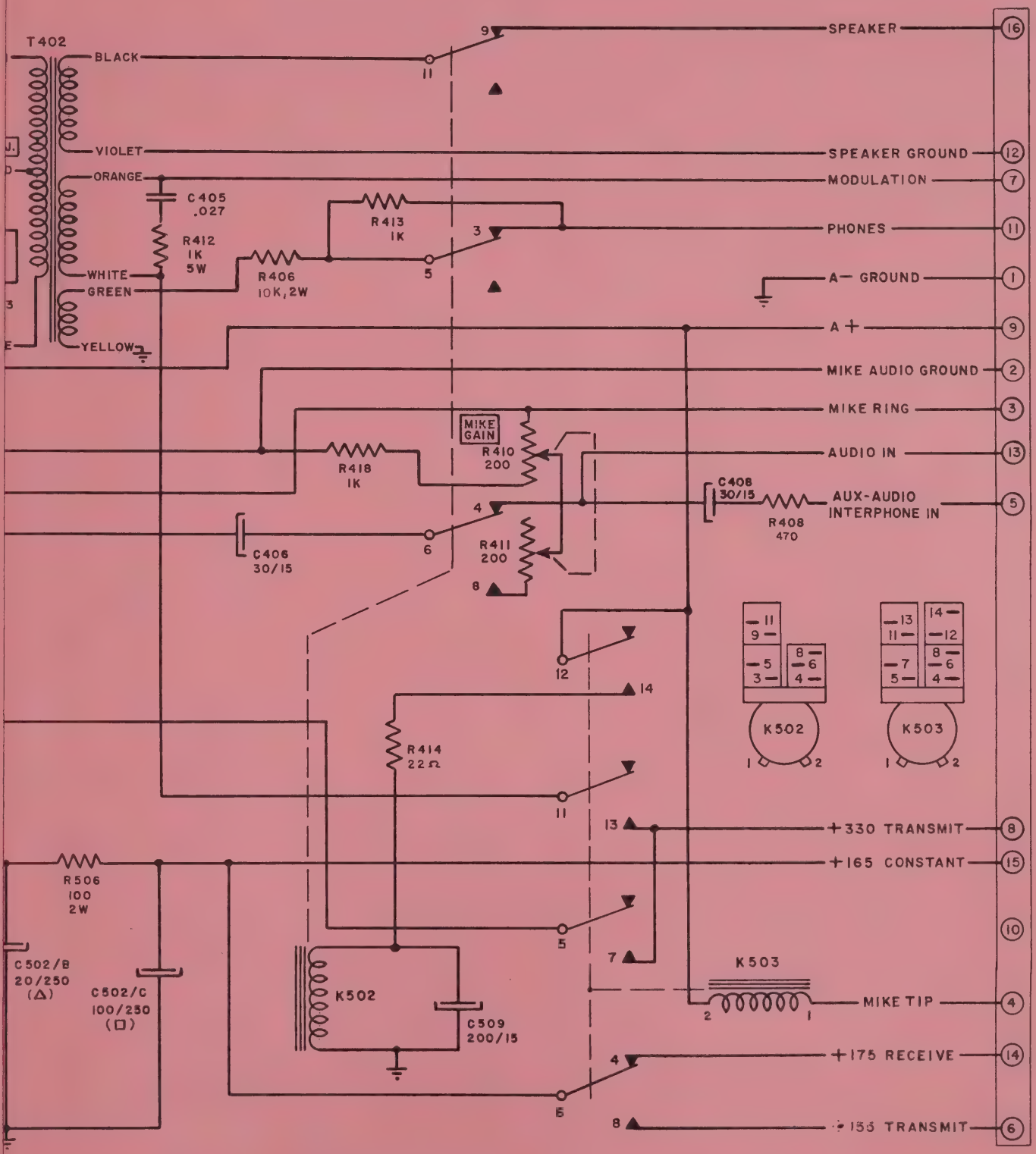
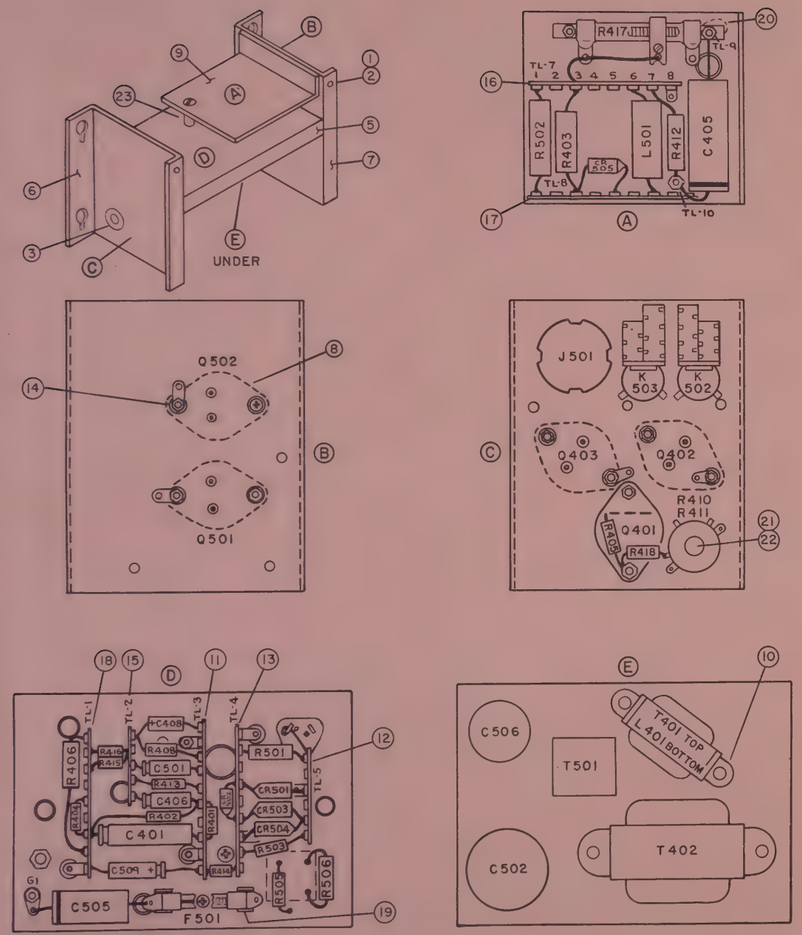


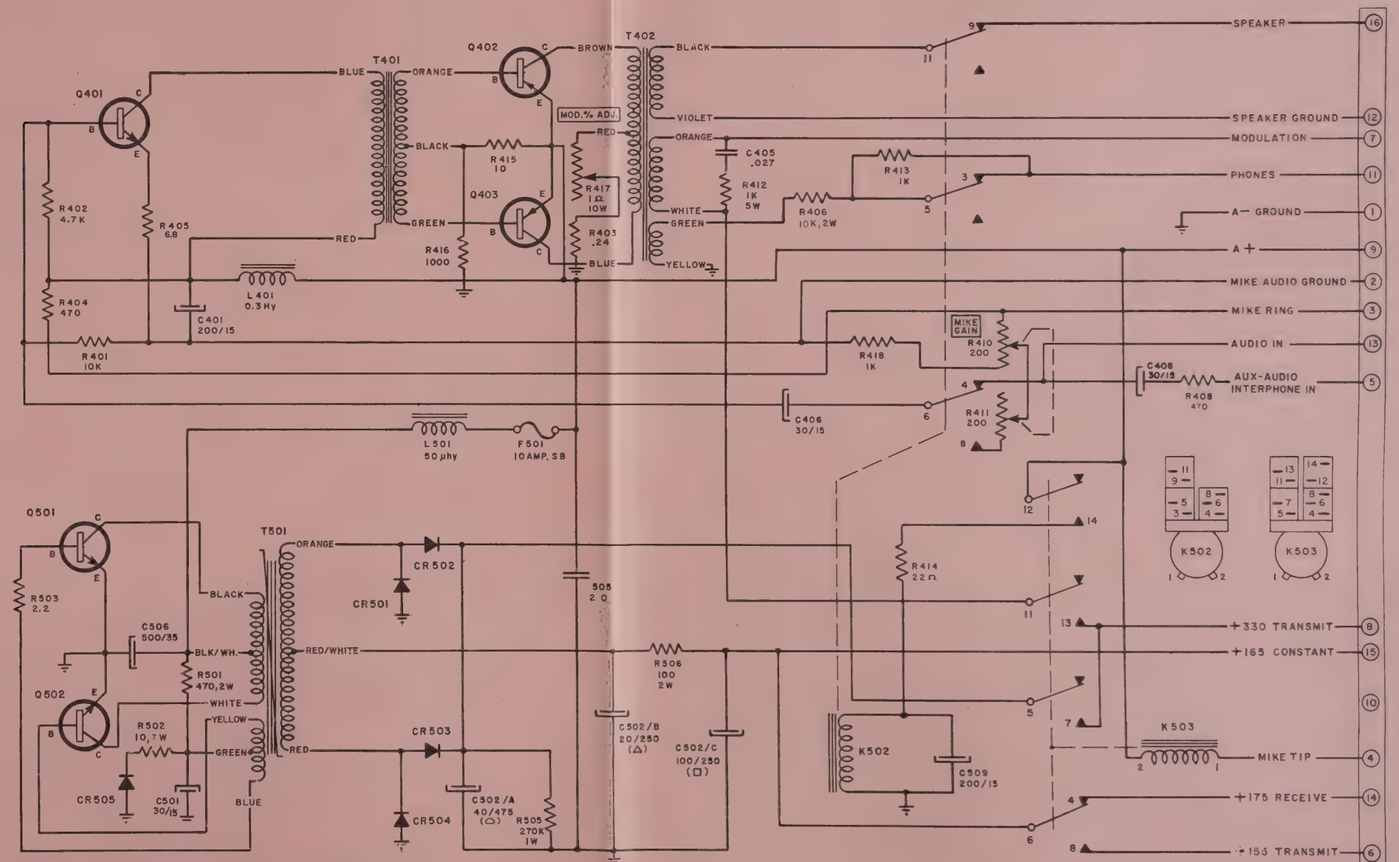
FIGURE 41. MODULATOR-POWER UNIT, T (12) MP-12AH-1
(Drawing and Schematic)



PARTS LOCATION DRAWING

TEST POINTS

See Fig. 39 for test points and values.



NOTES:
A– ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B– ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS.
K = 1000 MEG = 1,000,000
C– RELAYS SHOWN IN RECEIVE POSITION.

FIGURE 41. MODULATOR-POWER UNIT, T (12) MP-12AH-1 (Drawing and Schematic)

TEST POINTS

See Fig. 40 for test points and values.

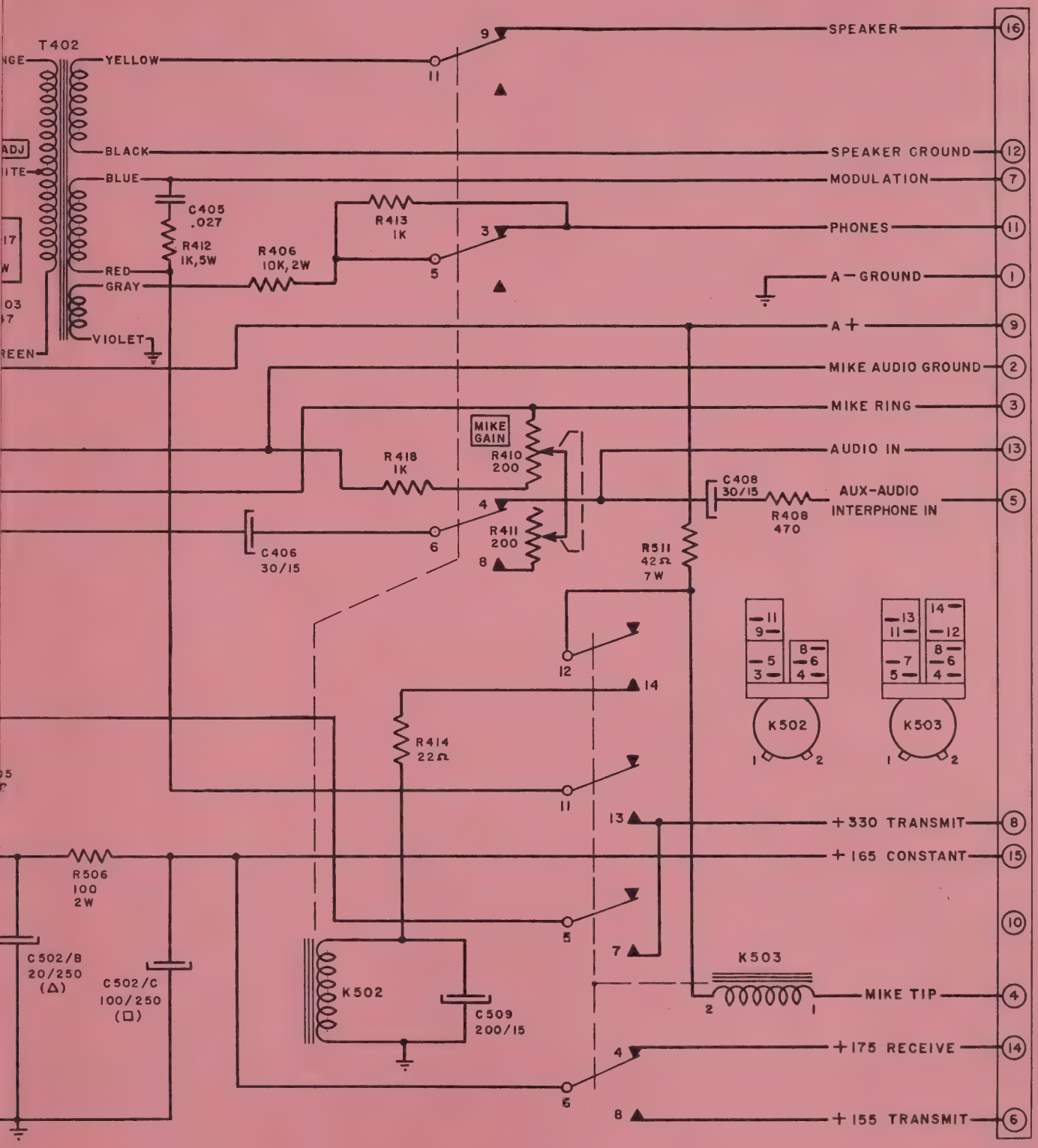
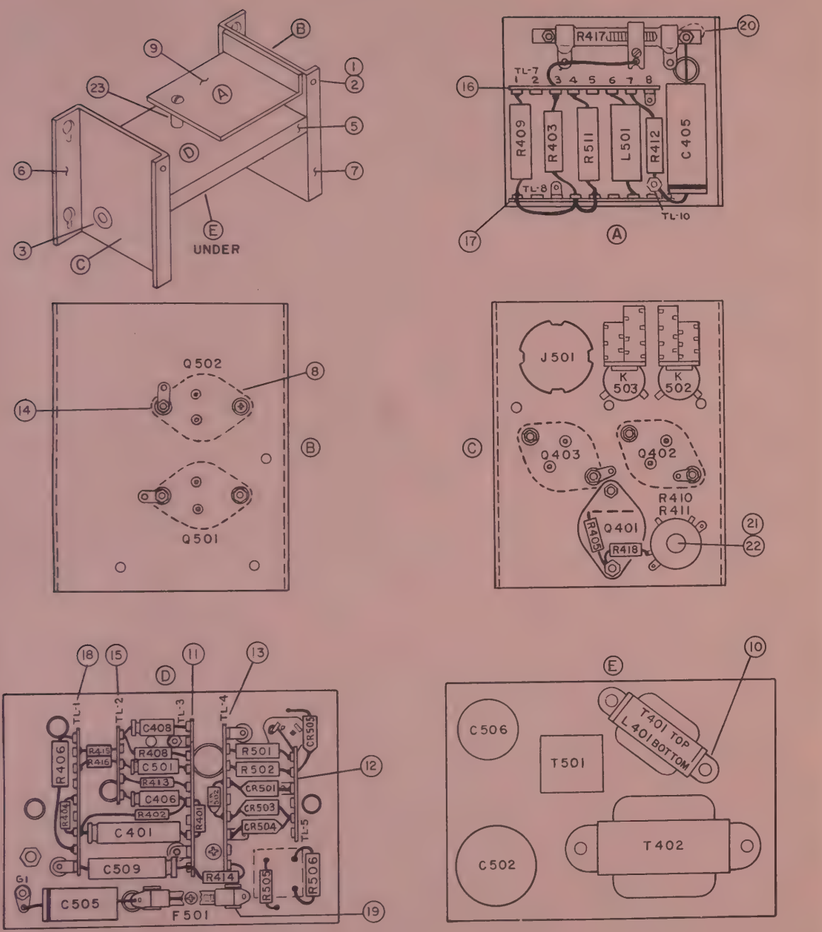


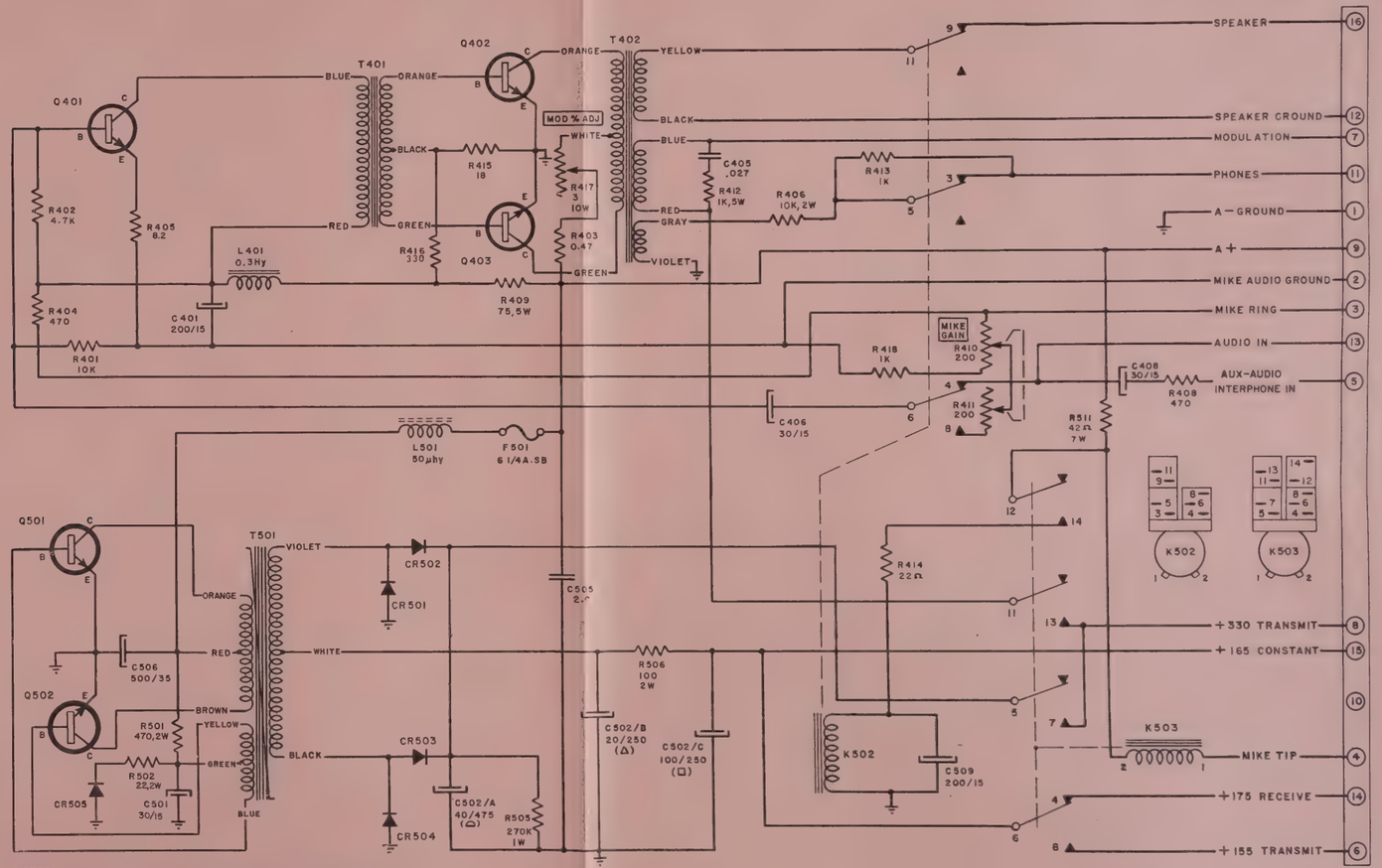
FIGURE 42. MODULATOR-POWER UNIT, (T24) MP-12AH-1
(Drawing and Schematic)



PARTS LOCATION DRAWING

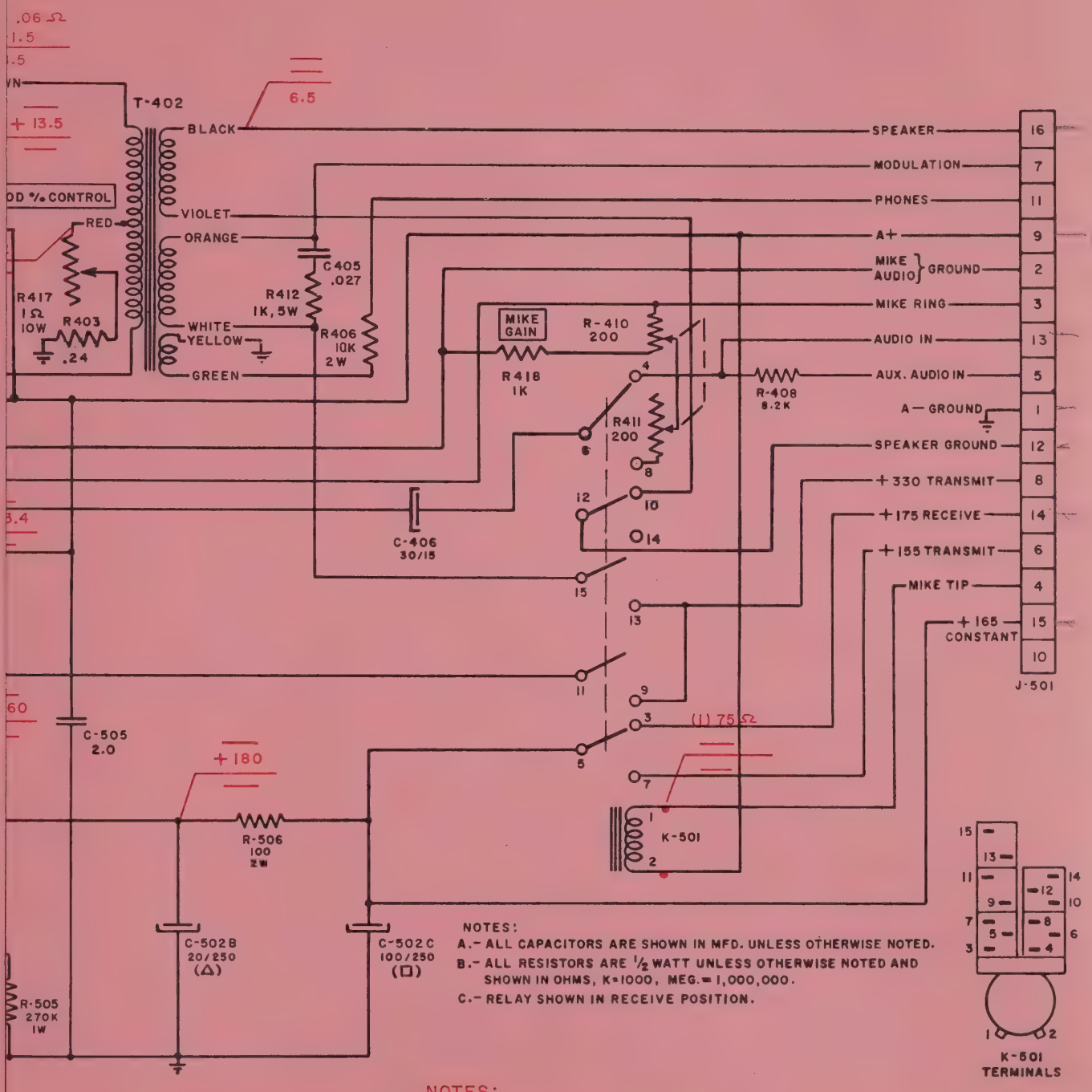
TEST POINTS

See Fig. 40 for test points and values.



NOTES:
A- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B- ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG=1,000,000.
C- RELAYS SHOWN IN RECEIVE POSITION.

FIGURE 42. MODULATOR-POWER UNIT, (T24) MP-12AH-1 (Drawing and Schematic)

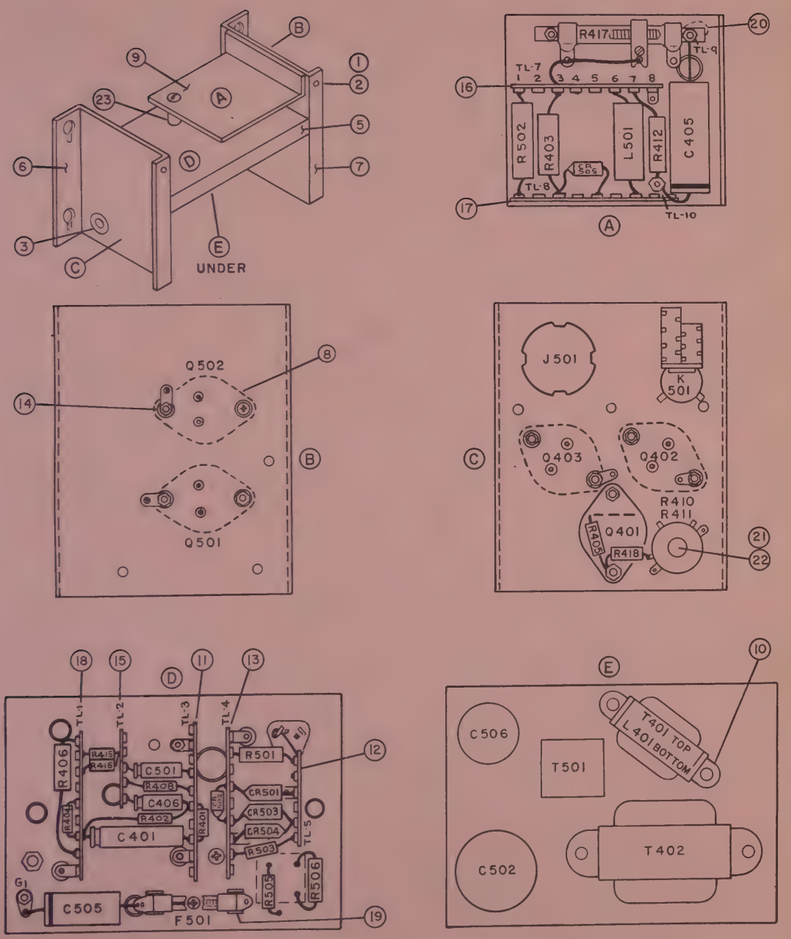


NOTES:
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.
C.- RELAY SHOWN IN RECEIVE POSITION.

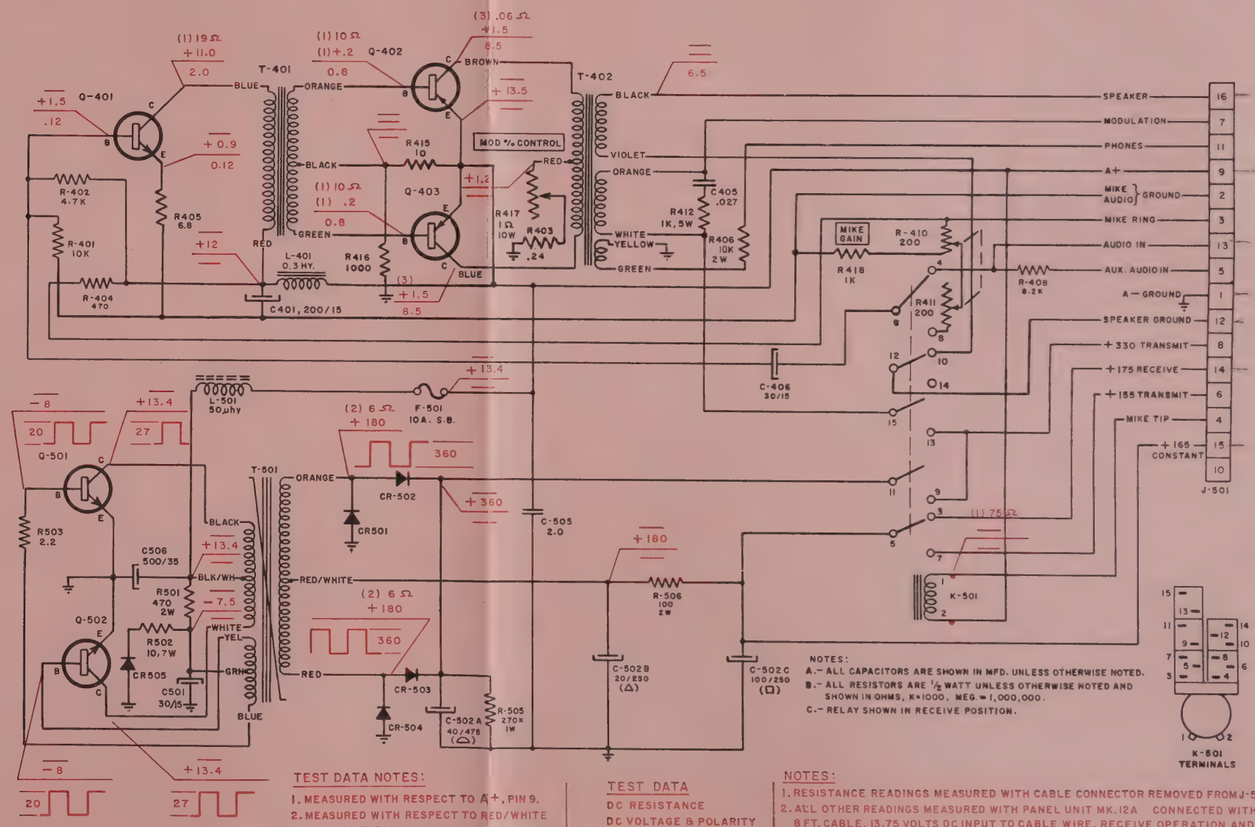
TEST DATA
DC RESISTANCE
DC VOLTAGE & POLARITY
AC VOLTAGE OR
WAVESHAPE & P-P VOLTAGE

NOTES:
1. RESISTANCE READINGS MEASURED WITH CABLE CONNECTOR REMOVED FROM J-501.
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 13.75 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000 Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE VTVM OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

FIGURE 39. MODULATOR-POWER UNIT, T(12) MP-12A-1
(Drawing and Schematic)



PARTS LOCATION DRAWING



TEST DATA NOTES:

1. MEASURED WITH RESPECT TO A+, PIN 9.
2. MEASURED WITH RESPECT TO RED/WHITE LEAD OF T-501.
3. MEASURED WITH RESPECT TO CHASSIS GROUND.

TEST DATA

DC RESISTANCE

DC VOLTAGE & POLARITY

AC VOLTAGE OR WAVESHAPE & P-P VOLTAGE

NOTES:

A.– ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.– ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG = 1,000,000.
C.– RELAY SHOWN IN RECEIVE POSITION.

NOTES:

1. RESISTANCE READINGS MEASURED WITH CABLE CONNECTOR REMOVED FROM J-501.
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 13.75 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000 Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE [illegible] OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

FIGURE 39. MODULATOR-POWER UNIT, T(12) MP-12A-1 (Drawing and Schematic)

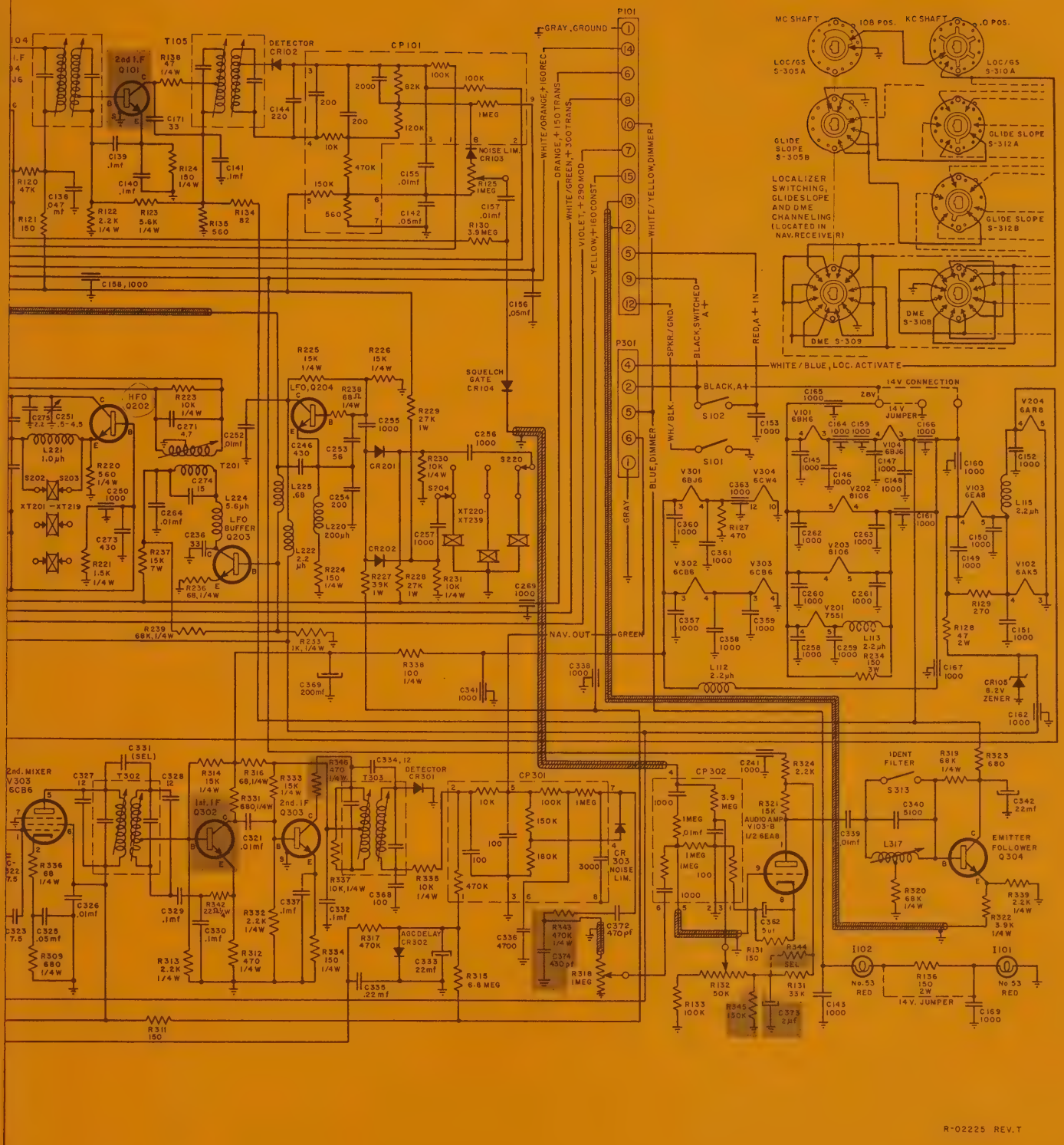


Figure 43 MARK 12A, SCHEMATIC FOR CN-144-B7, B8, B9 and B10

NARCO AVIONICS MARK 12A

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place.

GENERAL

The Mark 12A (any chassis number) may be mated with any of the older MP-12's or the newer MP-12A-1, Modulator-Power Unit (of proper voltage). However, should a Mark 12A, chassis number CN-144-B7 or below be mated to a MP-12A-1, the Mark 12A must be modified by adding C373, C374, and R343. (See CN-144-B8 change.)

CN-144-B7 — No electrical or mechanical changes.

CN-144-B8 — C373 was added to stablize squelch operation with DC line voltage changes.
To compensate the Mark 12A when mated to a Modulator-Power Unit, MP-12A-1 or MP-12AH-1 (12 & 24), C374 and R343 were added. Without this compensation a VOR course error developes when turned to maximum volume.

C373	P/N	21554-35 CAPACITOR, ELECTROLYTIC, 2μf -10% + 30%,200v added
C374	P/N	21291-25 CAPACITOR, DISC CERAMIC, 430pf ±10%, 500v added
R343	P/N	31192-474 RESISTOR, FIXED COMPOSITION, 470K ±10%, ¼w added

CN-144-B9 — Engineering design to eliminate keying sound during transmission.

R344	P/N	31192-Selected RESISTOR, FIXED COMPOSITION, ±10%, ¼w added
R345	P/N	31141-154 RESISTOR, FIXED COMPOSITION, 150K ±10%, ¼w added
C232		schematic was in error . . . symbol number should be C272. correction

CN-144-B10 — R346 added to improve stability of NAV IF.
Other components changed due to new source of the components and to improve crystal performance.

Q101	P/N	75568-2 TRANSISTOR, SILICON, NPN changed
Q301	P/N	75568-2 TRANSISTOR, SILICON, NPN changed
Q302	P/N	75568-2 TRANSISTOR, SILICON, NPN changed
C311	P/N	21291-25 CAPACITOR, DISC CERAMIC, 430pf ±10%, 500v changed
C343	P/N	21291-25 CAPACITOR, DISC CERAMIC, 430pf ±10%, 500v changed
C346	P/N	21291-25 CAPACITOR, DISC CERAMIC, 430pf ±10%, 500v changed
R346	P/N	31192-471 RESISTOR, FIXED COMPOSITION, 470ohm ±10%, ¼w added

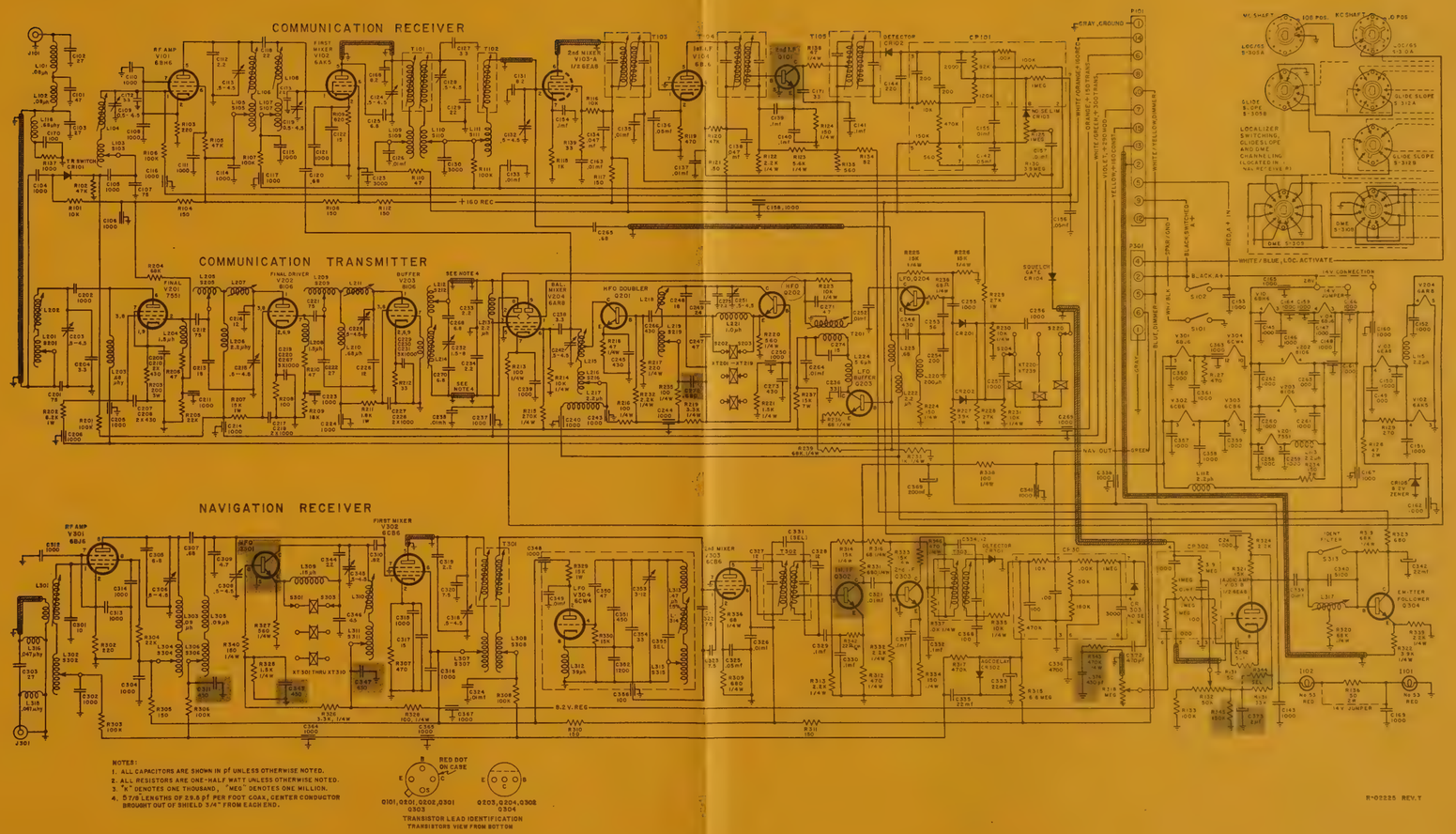

COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 5'/8 LENGTHS OF 29.8 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

Figure 43 MARK 12A, SCHEMATIC FOR CN-144-B7, B8, B9 and B10

How are we doing?

We at Narco welcome your comments and suggestions about the manuals, both good and bad. These are the best indicators of how informative the manual is to you, the ultimate user.

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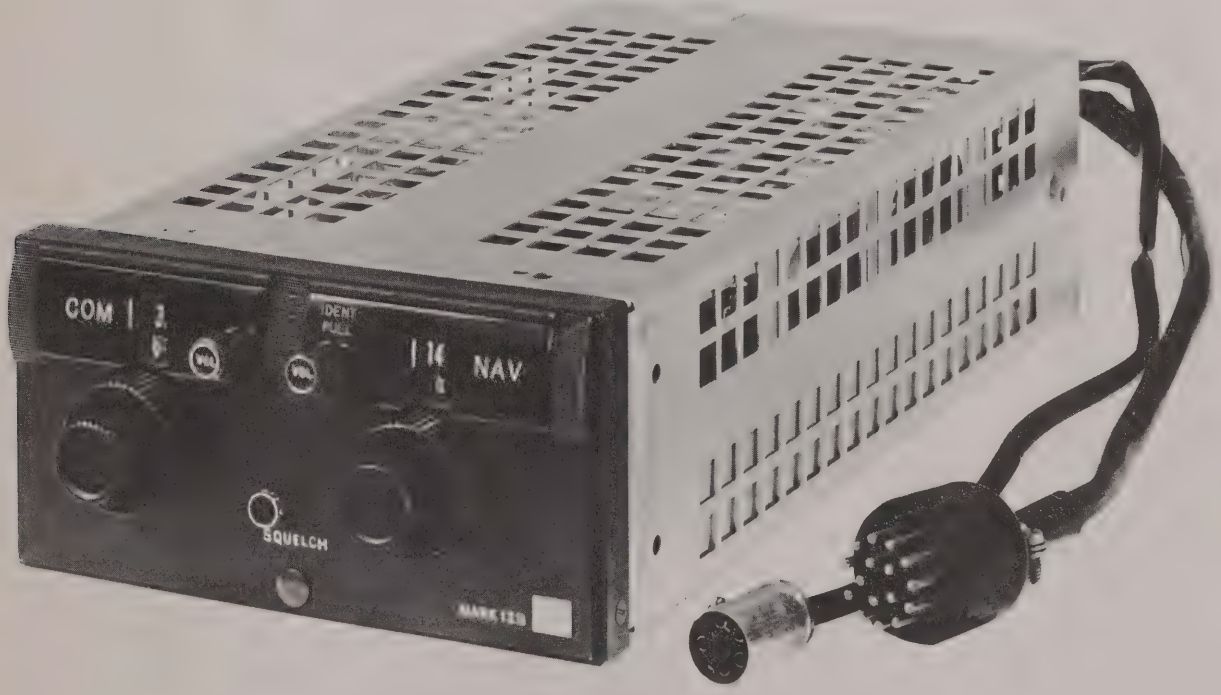
NARCO AVIONICS

MARK-12B NAV / COM

MAINTENANCE MANUAL



NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

Printed in U.S.A. 3083-600 Updated to Sept. 15, 1969

This manual has been updated to include data covering all chassis up to and including CN195-B9.

The following "List of Effective Pages" indicates those pages which make-up this manual and their date of issue.

LIST OF EFFECTIVE PAGES

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2-7	Orig	4-17	Orig	6-6	Blank
2-8	Orig	4-18	Orig	6-7	Orig
2-9	Orig	4-19	Orig	6-8	Blank
2-11	9/15/69	4-20	Orig	6-9	Orig
2-12	Orig	4-21	Orig	6-10	Blank
2-13	Orig	4-22	Orig	6-11	Orig
2-14	Orig	4-23	Orig	6-12	Blank
2-15	Orig	4-24	Orig	6-13	Orig
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3-1	Orig	4-26	Orig	6-15	Orig
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3-3	Orig	4-28	Blank	6-17	Orig
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3-7	Orig	5-4	Orig	6-21	Orig
3-8	Blank	5-5	Orig	6-22	Blank
4-1	Orig	5-6	Orig	6-23	Orig
4-2	Orig	5-7	Orig	6-24	Blank

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1.1 GENERAL

The NARCO AVIONICS MARK 12B is a combination VHF communication transceiver and a wholly independent VHF navigation receiver using advanced circuit techniques for high reliability.

The Mark 12B consists primarily of two units, the instrument panel mounted Panel Unit and the Modulator-Power Unit which may be mounted horizontally or vertically in any convenient location desired.

1.1.1 Panel Unit

The Panel Unit contains the communication transceiver and navigation receiver sections.

The VHF transceiver is designed to be used as a primary communications apparatus. It is controlled by the left hand frequency selector of the Panel Unit. It is available with either 90 or 360 crystal controlled channels. A kit of crystals obtainable from NARCO can be installed at any time to convert a 90 channel Mark 12B for operation on 360 channels. Both receiver and transmitter are controlled by the same channel selector. A 100 channel VHF navigation receiver is controlled by the right hand frequency selector. Used with an OMNI converter it can provide complete VOR/LOCALIZER navigation. An IDENT filter eliminates the code identification from a NAV signal so voice communications can be clearly understood. Pulling the NAV volume control knob disables the filter to permit positive identification of the station. The navigation receiver is not cut off while transmitting. OMNI or LOCALIZER signals are therefore available at all times. This feature is especially desirable if an autopilot is coupled to the OMNI converter. The navigation receiver contains glide slope and DME channel selector switches. Cable and connector kits may be installed at any time to connect these switches to a glide slope receiver, a DME interrogator, or both.

1.1.2 Modulator-Power Units, T(12) or T(24) MP-12A-1 and MP-12AH-1

The Modulator-Power Unit contains the power supply and audio-modulator.

A common power amplifier provides both communication and intercommunication between pilot and co-pilot. The audio input circuit is designed for a level of 50 milliwatts from a 300 ohm source. An auxiliary audio input circuit is provided so that one or more radio equipments may be connected to operate through the Unit.

These Units have been designed to be mounted either horizontally or vertically by means of the mounting base supplied.

The "AH" Units are designed for helicopter application however, an "AH" Unit may be used in conventional aircraft if desired.

Figure 1-1 MARK 12B NAV/COM

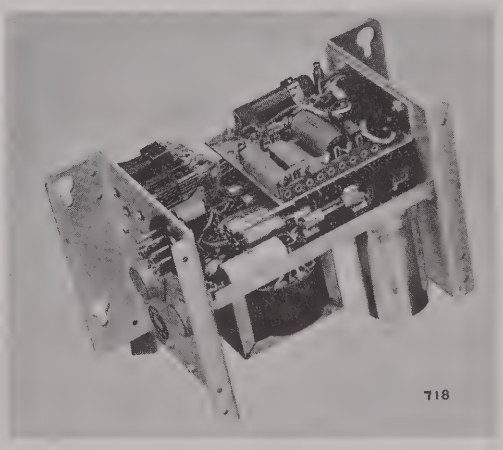


Figure 1-2 MODULATOR-POWER UNIT (Typical)

2.1 INTRODUCTION

This section provides the necessary information for the identification, installation, and checkout of the NARCO AVIONICS Mark 12B.

2.2 UNITS AND ACCESSORIES SUPPLIED

1. NARCO Mark 12B
   a. Domestic: 90 or 360 Communication Channels, as ordered.
   b. Export: 100 or 360 Communication Channels, as ordered.
2. Power Audio Unit
   T(12) MP-12A-1 or MP-12AH-1 for 14 volt operation,or
   T(24) MP-12A-1 or MP-12AH-1 for 28 volt operation, as ordered.
3. Antenna connector, COM Transceiver. NARCO Part No. 41130-2.
4. Antenna connector, NAV. Receiver. NARCO Part No. 41237-1, Plug; with 41237-2 Ferrule.
5. Mounting base plate, for T(12) or (24) MP-12A-1 or MP-12AH-1 NARCO Part No. 52085-101.
6. OMNI Connector, NARCO Part No. 41117-1 .
7. Front Panel Labels (NAV 1, NAV 2, COM 1, COM 2) NARCO Part No. 04271-1

2.3 ACCESSORIES REQUIRED, But Not Supplied

1. CABLE: Modulator-Power and Accessory.
   a. 8 feet long, NARCO Part No. 90618-96 or 90635-96.
   b. 16 feet long, NARCO Part No. 90618-192 or 90635-192.
2. COMMUNICATION ANTENNA. See Section 2-10.
3. NAVIGATION ANTENNA: NARCO VRP-37, or equivalent. See paragraph 2.10.2
4. COMMUNICATION ANTENNA CABLE, See paragraph 2.10.1.
5. NAVIGATION ANTENNA CABLE, See paragraph 2.10.2.
6. Headphones: Low Impedance type, 300 to 1000 ohms, or Loud Speaker, Voice coil impedance, 3 to 6 ohms nominal. Both headphones and speaker may be used if desired.
7. Microphone: Carbon, noise cancelling carbon (low impedance), or dynamic with transistor pre-amp. The quality of transmission depends to a considerable extent on the quality of the microphone used. A noise cancelling type is very helpful and is recommended.

2.4 OPTIONAL UNITS and ACCESSORIES AVAILABLE

2.4.1 Cables and Connectors

a. Glide Slope Switching Cable and Connector Kit: (required if a glide slope receiver is to be controlled by the switches provided in the Mark 12B, NARCO Part No. EL-3077-500.

b. DME Switching Cable and Connector Kit; (required if a DME interrogator is to be controlled by the switches provided in the Mark 12B) NARCO Part No. EL-3077-501.

c. Connector Kit, for Modulator-Power and Accessory Cable (required for field fabrication of of the main interconnecting cable), NARCO Part No. EL-3077-502.

2.4.2 Navigation Converters

a. NARCO VOA-8 Navigation Converter, for OMNI LOCALIZER Course Indications.

b. NARCO VOA-9 Navigation Converter, for OMNI, LOCALIZER, or Glide Slope Course Indications.

c. NARCO VOA-40 Navigation Converter, for OMNI or LOCALIZER Indications.

d. NARCO VOA-40M Navigation converter, for OMNI, LOCALIZER, and Marker Light indications.

e. NARCO VOA-50M Navigation Converter, for OMNI, LOCALIZER, Glide Slope, and Marker Light Indications.

f. NARCO UGR-2 Glide Slope Receiver, 20 channel model.

g. NARCO MBT-R, Marker Beacon Receiver.

2.4.3 Quartz Crystals

a. Crystal Kit for conversion of Mark 12B Transceiver from 90 to 360 Communication Channels. NARCO Part No. EL-3077-503.

2.5 SPECIFICATIONS

2.5.1 General

a. Size:
Panel Unit: See Figure 2-1
Modulator-Power Unit: See Figure 2-2
b. Weight:
Panel Unit: 5.7 pounds.
Modulator-Power Unit: 3.9 pounds.
c. Power Required:

At 13.75 Volts,	4.6 amps	Receive,
	7.9 amps	Transmit.
At 27.50 Volts,	2.1 amps	Receive,
	4.9 amps	Transmit

2.5.2 Communication Transceiver

a. Frequency Range, Domestic Equipment.

90 Channel Equipment:
118.0 thru 126.9 Megahertz
(100 kHz Channel Spacing)
360 Channel Equipment:
118.00 thru 135.95 Megahertz
(50 kHz Channel Spacing)

b. Frequency Range, Export Equipment.

100 Channel Equipment:
117.0 thru 126.9 Megahertz
(100 kHz Channel Spacing)
360 Channel Equipment:
117.00 thru 135.95 Megahertz
(50 kHz Channel Spacing)

2.5.3 Communication Transmitter

Power Output:
Nominal 10 watts.
Sidetone:
50 Milliwatts
Modulation:
70% minimum at start of limiting.
Frequency Stability:
Maximum 0.005% over temperature range of -30 C to +55 C, and line voltage range of 10V to 16V (14V unit) or 20V to 32V (28V unit).
Line Voltage: Will operate, capable of intelligible modulation, over line voltage range of 10 to 16V (14V unit) or 20 to 32V (28V unit)
Microphone:
Carbon, noise cancelling carbon (low impedance) or dynamic with transistor pre-amp. to be used.
Duty:
Maximum 50%. (1 minute on, 1 minute off)

2.5.4 Communication Receiver

Sensitivity:
1.5 microvolts maximum for 6 db signal + noise ratio.
Overall Selectivity:
6 db (nose), 30 kHz minimum bandwidth.
60 db (skirt), 90 kHz maximum bandwidth.
Image Rejection:
At least 60 db.
AGC:
4 db from 10 to 10,000 microvolts.
Audio output:
10 watts into 4 ohms.

2.5.5 Navigation Receiver

Frequency Range:
108.0 thru 117.9 MHz
(100 kHz Channel Spacing).
Sensitivity:
1.0 microvolt for 6 db signal + noise to noise ratio.
Overall Selectivity:
6 db (nose), 20 kHz minimum bandwidth.
60 db (skirt), 95 kHz maximum bandwidth.
Image Rejection:
At least 70 db.
AGC:
4 db from 10 to 10,000 microvolts.
Tone Filter:
Provides 20 db IDENT rejection.
Audio Output:
10 watts into 4 ohms.

2.6 LICENSE REQUIREMENTS

The Federal Communications Commission requires that the operator of the transmitter in this equipment hold a Restricted Radio Telephone Operator Permit, or higher class license. A permit may be obtained by any U.S. citizen from the nearest field office of the FCC; no examination is required.

The transmitter itself, as installed in the aircraft, requires an Aircraft Radio Station License. This license is obtained by filing FCC Form 404. The Mark 12B may be operated for up to 30 days without a station license, after filing the FCC Form 404 and while awaiting receipt of the station license, providing a copy of the FCC Form 404 is kept in the aircraft.

This equipment has been type accepted by the FCC and entered on their list of type accepted equipments as "NARCO Mark 12B" and it must be identified as "NARCO Mark 12B" on your FCC Form 404, Aircraft Radio Station License Application.

CAUTION

The VHF transmitter in this equipment is guaranteed to meet Federal Communications Commission approval only when NARCO crystals are used.
Use of other than NARCO crystals will void manufacturer's warranty.

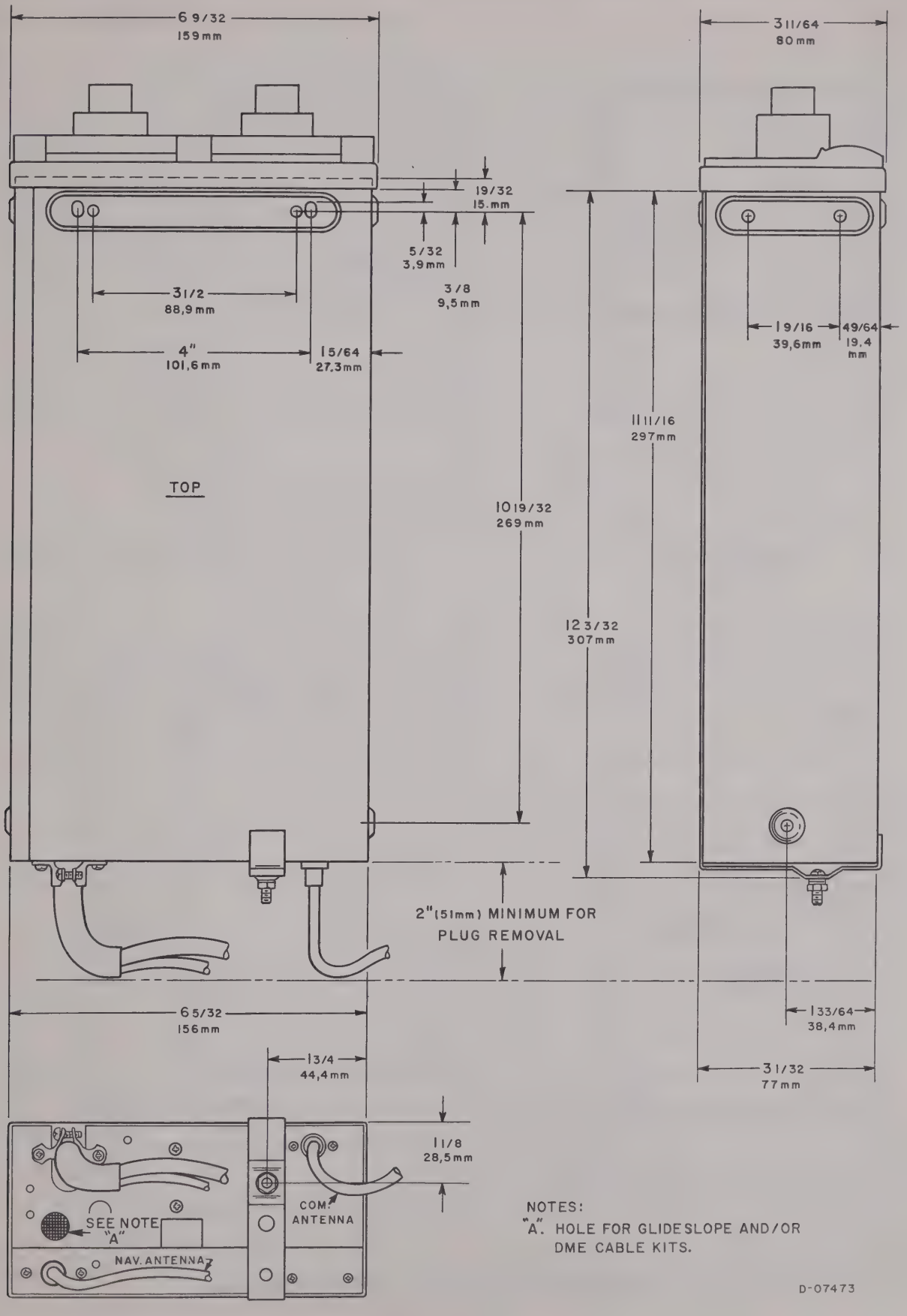


Figure 2-1 MARK 12B INSTALLATION DWG.

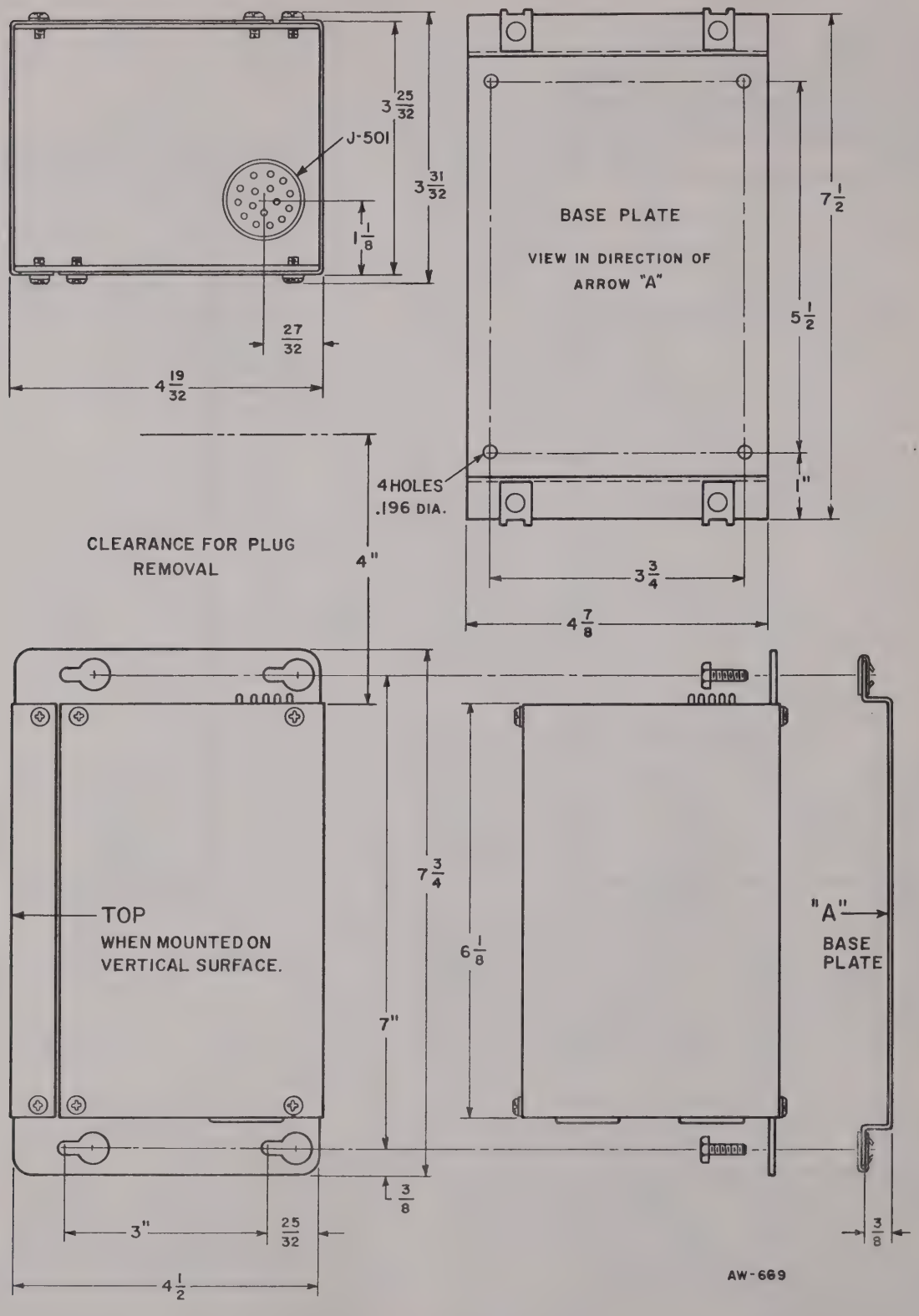


Figure 2-2 MODULATOR-POWER UNIT INSTALLATION DWG.

2.7 MECHANICAL INSTALLATION

The NARCO Mark 12B Panel Unit is secured to its case by a screwdriver operated latch located under the snap-in button on the front panel. The most desirable installation for the best appearance is to mount the case from the rear of the instrument panel. A cutout 6-5/32 x 3-1/32 inches high is required in the instrument panel to allow the Panel Unit to slip thru and be secured in place, leaving only the front trim portion visible. (See figure 2-14, removable for a full-size cutout template.) If for any reason the case cannot be rear mounted, the instrument panel cutout should measure 6-9/32 x 3-5/32 inches high to allow the case to slip thru.

This installation will leave a visible gap around the trim panel. A cover plate can be fabricated and secured to the instrument panel after installing the case to enhance the appearance of this type of installation. (See Figure 2-14, removable for a full-size cutout template.)

2.7.1 Case Mounting Supports

The Panel Unit is supported by its case which is provided with drilled "bosses" on the top, bottom, and sides to accommodate binding head screws. Mounting brackets to mate these bosses are not supplied due to the wide margin in mounting requirements. Suitable mounting brackets may be fabricated from ordinary metal sheet or angle stock.

The 10-32 machine screw provided at the rear of the case performs a dual function:

(1.) An electrical ground connection, and (2.) a mechanical rear support attachment point.

To support the rear of the case a metal bracket should be fabricated and attached to the 10-32 machine screw and a firm airframe member. The airframe-bracket joint must make good electrical connection, or a separate ground strap must be provided.

To provide sufficient support, the case should be mounted in ONE of the following methods. (See Figure 2-3.)

1. Screws and bracket at: A and B, plus G or H.
2. Screws and ground strap at: A, B, E, and F, plus I
3. Screws and bracket at C and D, plus G or H.
4. Screws and ground strap at: C, D, E, and F, plus I.

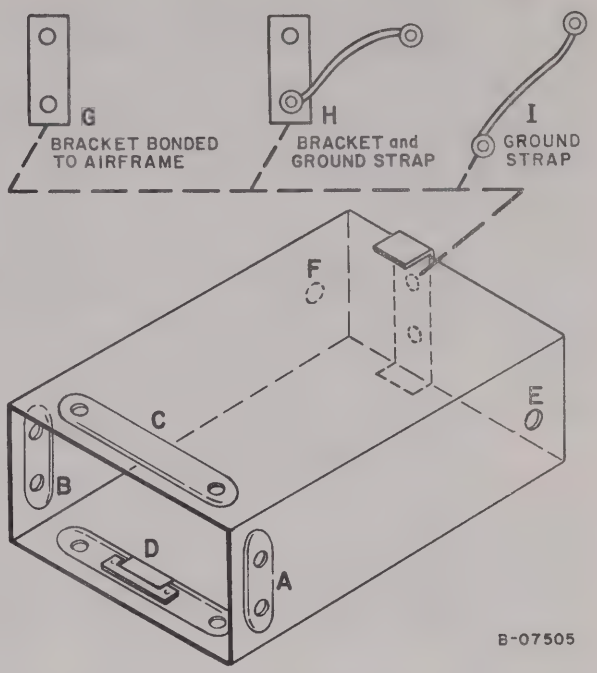


Figure 2-3 CASE MOUNTING

2.7.2 Front Panel Labels

For installation convenience and professional operational identification, a set of self-adhering labels for the Mark 12B is provided with each equipment. These labels are designed to be affixed, as shown in Figure 2-8, to the Mark 12B in multiple equipment installations to identify navigation and communication systems 1, 2, and 3.

1 2 3

NARCO Part No. 04366-0001

2.7.3 Modulator-Power Unit

A Mounting Base is provided to be permanently installed in the aircraft. The Modulator-Power unit is attached to this base in a manner which permits easy removal for inspection or servicing. See Figure 2-2.

The Mounting Base and in turn the Modulator-Power Unit must have a good electrical ground, similar to the Panel Unit.

2.8 ELECTRICAL CONNECTIONS

The NARCO Mark 12B Equipment consists primarily of a Panel Unit which becomes the central point for the electrical connections to the Modulator-Power Unit and to all other accessories. All connections are associated with the rear of the Panel Unit chassis. The rear of the chassis is readily accessible because the rear of the outside case is open, except for a narrow vertical strap which holds the ground support stud.

All connections except the two separate antennas (Communication and Navigation) are made via two connectors attached to a short cable having two branches, extending from the rear of the Panel Unit chassis.

2.8.1 Modulator-Power and Accessory Cable

The Panel Unit Cable branch having the large 16 pin connector, P-101, is to be connected to J-501, on the Modulator-Power (MP) Unit. Figure 2-4 and 2-5 gives the circuits between the mating connectors P-102 and P-501, corresponding with the Panel Unit connector P-101 and the MP Unit connector J-501 respectively.

The Cable Assemblies made by NARCO (See 2.3-1) have, in addition to the connections to the MP connector P-501, a five wire, six foot cable breakout for the usual microphone, headphone, and loudspeaker connections. Also extending from the opening in the P-102 Cable Connector Shell are three wires about 16 inches long A + input, panel lamp dimmer, and auxiliary audio input.

2.8.2 OMNI/LOCALIZER Cable

The Panel Unit Cable branch having the small 6 circuit pin P-301 is provided for connection via a mating connector to an OMNI Converter Unit such as the NARCO VOA-8, VOA-9, VOA-40, VOA-40M or the VOA-50M. Connections for such units are given in Table 2-1 and in the information supplied with the various OMNI Converter Units.

The OMNI/LOCALIZER cable should be routed as far as possible from the COM antenna and its cable. Excessive RF pickup on the OMNI/LOCALIZER cable may cause an OMNI needle deflection while transmitting.

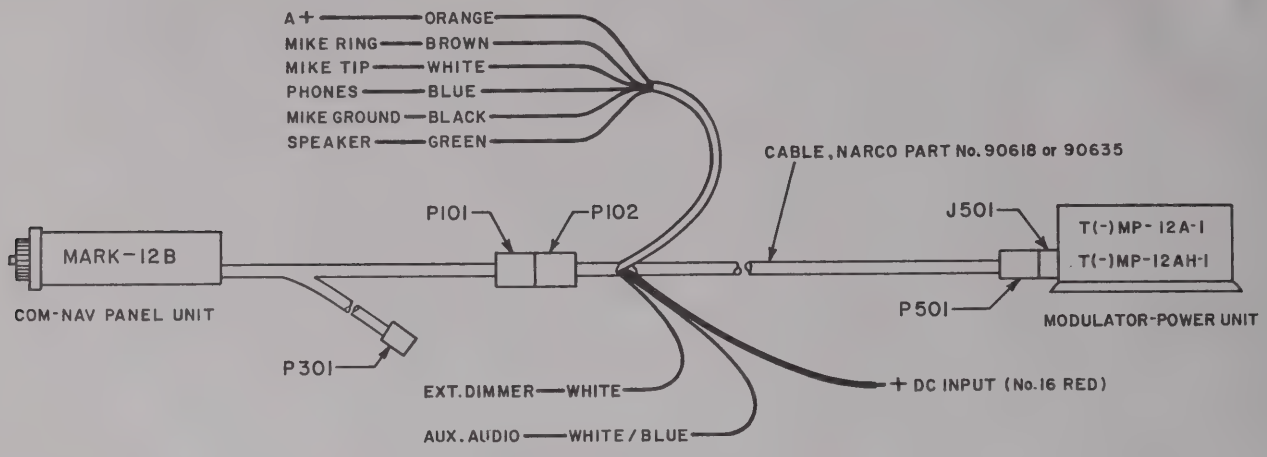
2.8.3 Glide Slope Channel Selector Cable.

The Navigation Receiver Channel Selector is provided with switch sections for simultaneous and automatic Glide Slope Receiver Channel Selection.

To use this switching with a Glide Slope Receiver such as the NARCO UGR-2, it is necessary to make connections directly to certain switch sections in the Mark 12B Navigation Receiver Channel Selector Assembly. The cable is brought out of the Panel Unit through the round hole in the rear panel, beneath the Modulator-Power and accessory cable. Information on the location of the switch sections and the required connections is given in the instructions accompanying the Glide Slope Channel Selector Cable and Connector Kit. (See paragraph 2.4.1a).

TABLE 2-1 PANEL UNIT CONNECTIONS

P-301 Terminal No.	Wire Color	Wire Size	Circuit Function
1	Grey	#18	Ground
2	Black	#18	+ DC Supply
3	No Conn.	---	---
4	White/Blue Tr.	#22	OMNI/LOC. Relay
5	Blue	#22	Ext. Dim for VOR
6	Green	#22	OMNI Signal



NOTE : CONNECTORS ON BOTH ENDS OF CABLE (90618 OR 90635) ARE ALIKE BUT EQUIPMENT WILL OPERATE ONLY WHEN CABLE IS INSTALLED AS SHOWN, WITH POWER AND ACCESSORY WIRES AT PANEL UNIT END. B-07502

Figure 2-4 MARK 12B TO ACCESSORIES INTERCONNECTION DRAWING

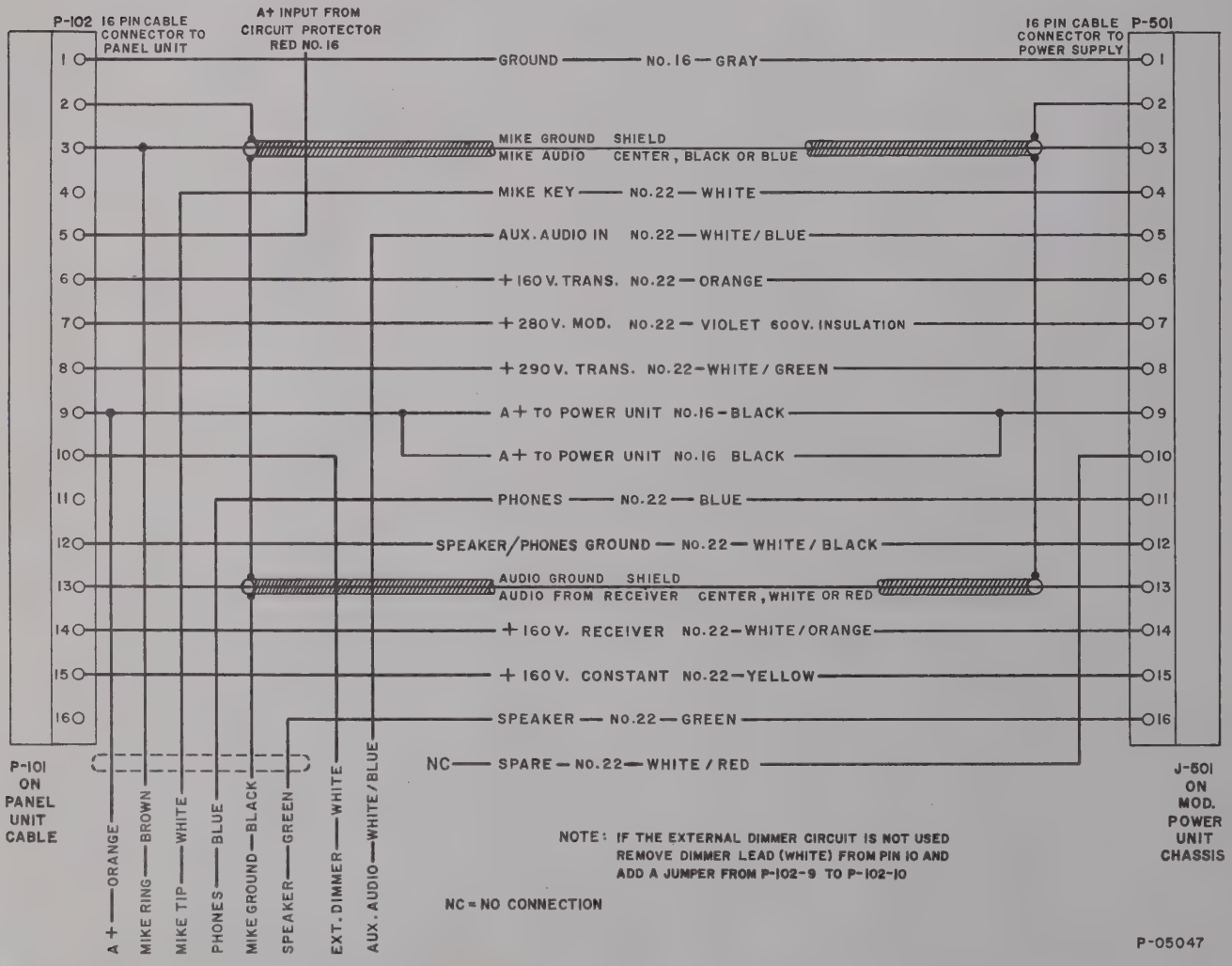

P-102 16 PIN CABLE CONNECTOR TO PANEL UNIT
A+ INPUT FROM CIRCUIT PROTECTOR RED NO. 16
16 PIN CABLE CONNECTOR TO POWER SUPPLY P-501
GROUND — NO. 16 — GRAY
MIKE GROUND SHIELD
MIKE AUDIO CENTER, BLACK OR BLUE
MIKE KEY — NO. 22 — WHITE
AUX. AUDIO IN NO. 22 — WHITE/BLUE
+160 V. TRANS. NO. 22 — ORANGE
+280 V. MOD. NO. 22 — VIOLET 600V. INSULATION
+290 V. TRANS. NO. 22 — WHITE/GREEN
A+ TO POWER UNIT NO. 16 — BLACK
A+ TO POWER UNIT NO. 16 BLACK
PHONES — NO. 22 — BLUE
SPEAKER/PHONES GROUND — NO. 22 — WHITE/BLACK
AUDIO GROUND SHIELD
AUDIO FROM RECEIVER CENTER, WHITE OR RED
+160 V. RECEIVER NO. 22 — WHITE/ORANGE
+160 V. CONSTANT NO. 22 — YELLOW
SPEAKER — NO. 22 — GREEN
NC — SPARE — NO. 22 — WHITE/RED
P-101 ON PANEL UNIT CABLE
J-501 ON MOD. POWER UNIT CHASSIS
A+ — ORANGE
MIKE RING — BROWN
MIKE TIP — WHITE
PHONES — BLUE
MIKE GROUND — BLACK
SPEAKER — GREEN
EXT. DIMMER — WHITE
AUX. AUDIO — WHITE/BLUE
NOTE: IF THE EXTERNAL DIMMER CIRCUIT IS NOT USED REMOVE DIMMER LEAD (WHITE) FROM PIN 10 AND ADD A JUMPER FROM P-102-9 TO P-102-10
NC = NO CONNECTION
P-05047

Figure 2-5 MARK 12B TO ACCESSORIES WIRING DIAGRAM

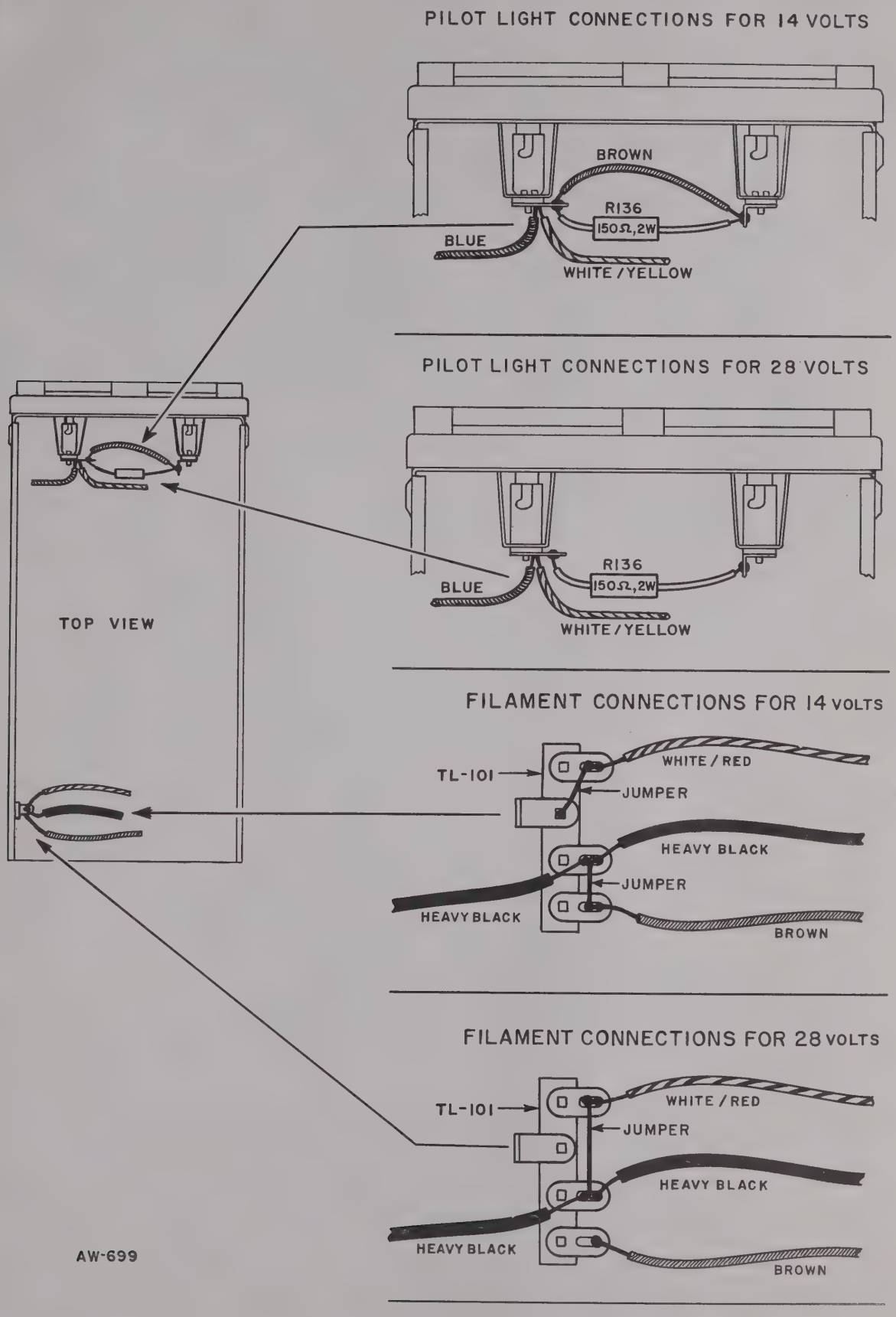


Figure 2-6 VOLTAGE CHANGEOVER CONNECTIONS

2.8.4 DME Channel Selector Cable

The navigation receiver contains switches for automatic DME channel selection.

To use this switching with a DME interrogator such as the NARCO UDI-2AR, a cable assembly must be connected to the DME switches in the Mark 12B. The cable is brought out of the Panel Unit through the round hole in the rear panel, beneath the Modulator-Power and accessory cable. Instructions accompanying the DME Channel Selector Cable and Connector Kit show the locations of the switches and the connections, (See paragraph 2.4.1b).

2.9 PRIMARY POWER

2.9.1 Power Source

The primary power source may be either a nominal 14 or 28 volts, depending on the connections in the Panel Unit and whether a T(12) or T(24) MP-12A-1 or MP-12AH-1 Modulator-Power Unit is used.

2.9.2 Circuit and Equipment Protection

The primary DC circuit to the equipment should be protected with a fuse or other protective device rated as follows:

15.0 amps for a nominal 14 volt installation.
7.5 amps for a nominal 28 volt installation.

2.9.3 Voltage Conversion

a. The Modulator-Power Units are made for either a nominal 14 or 28 volt operation and are not convertible from one voltage to the other.
b. The Panel Unit can be used in either a 14 or 28 volt installation. A few simple wiring changes in the filament and pilot lamp circuits constitute the voltage changeover. Figure 2-6 shows connections for 14 or 28 volts.

2.10 ANTENNA REQUIREMENTS

2.10.1 Communication

Satisfactory reception and transmission requires an antenna having a nominal impedance of 50 ohms and a low Voltage Standing Wave Radio (VSWR) over the frequency range to be used.

A simple antenna such as the NARCO VTP-17 bent whip may be used with a 90 channel Mark 12B. A broad-band antenna, such as the NARCO VP-10, is preferable with a 360 channel Mark 12B. A broad-band antenna is also recommended when a 90 channel Mark 12B is installed with the intention of converting to 360 channels later.

Only one antenna is necessary for communication, since antenna changeover switching is built into the Panel Unit. The communication antenna should be mounted on as large and flat a metallic surface as possible. A suitable surface is often found directly in front of the windshield in fabric covered ships. If no such surface exists, a suitable ground plane may be provided by cementing metal foil on the inside surface of the non-metallic structure. The communication antenna should be located at least 12 inches from other objects on the surface of the aircraft.

2.10.2 Navigation

In any VHF radio installation, the type of antenna and its location are extremely important. Only with the proper antenna in the best location can the full range and accuracy of the VHF OMNI Range system be realized. In installations where an OMNI converter is to be used with the NARCO Mark 12B navigation receiver *a horizontally polarized antenna is absolutely necessary.*

The quarter-wave whip, normally used for communications, is definitely not satisfactory, although it may appear to be when tried. While vertically polarized components of the OMNI signal are not normally radiated by the ground station, they are frequently produced by reflections. Therefore, a vertical antenna may receive strong signals not coming directly from the ground station, giving very unreliable bearing information.

If the Navigation Receiver in the NARCO Mark 12B Equipment is to be used for communication only, it may be connected to any communication type antenna which is not being used for transmission.

Either the NARCO VRP-15A mast-type or the NARCO VRP-37 fin-mounting Navigation Antenna may be used with the NARCO Mark 12B Navigation Receiver and an OMNI Converter. A combination NAV and COM antenna such as the NARCO VCNA-1 or VCNA-2 is not recommended since greater frequency separation will be required between NAV and COM channels for full NAV receiver sensitivity while transmitting.

The RF cable should be RG-58A/U of as short a length as is practical. All bends should have at least a 6" radius.

Two navigation receivers may be connected to one antenna if precautions are taken to provide proper impedance matching and isolation between receivers. A NARCO AVIONICS VP-15, VP-40, or VP-40A Antenna Diplexer is recommended. The VP-15 will provide about 2 db better receiver sensitivity and approximately 6 db more receiver-to-receiver isolation than the VP-40 or VP-40A. The latter two diplexers are, however, adequate for most installations. A simple coaxial tee or BNC tee is not recommended.

2.10.3 Important Antenna Information

For best navigation receiver performance while transmitting, the NAV and COM antennas should be well isolated from each other. The navigation antenna should always be located well away from the engine(s) and propellor(s), and at least two feet from other antennas or wires. A wire, such as an ADF sense antenna, running near the navigation and transmitting antenna can couple transmitter energy into the NAV receiver. A good arrangement is to use a VRP-37 fin-mounting navigation antenna on the vertical stabilizer, and to mount the communication antenna as far forward as possible.

Transmitting on frequencies within about one megahertz of a desired OMNI frequency will reduce NAV receiver sensitivity. The reduction in sensitivity becomes less as the transmitter frequency is separated more from the OMNI frequency. With frequency separation greater than about one megahertz, little desensitization will be observed.

Keying or unkeying the transmitter may produce a transient in the NAV receiver and the OMNI converter. This transient would be observed as a brief jump of the OMNI indicator needle. An autopilot coupled to the OMNI converter will not respond to this transient due to the long time constant in the coupler circuits.

2.11 MICROPHONE GAIN ADJUSTMENT

The microphone gain control, located in the Modulator Power Unit, is factory adjusted for carbon microphones. If a microphone with substantially higher output is to be used with the Mark 12B, the gain control should be readjusted as follows:

1. Recommended Method (Bench Adjustment)
   Connect the Mark 12B and the Modulator-Power Unit to a primary power source. Connect the microphone to the Modulator-Power and accessory cable. Connect an oscilloscope to the feed-thru capacitor located in the left front corner of the chassis (violet wire attached to this feed-thru). Connect a 50 ohm, 10 watt, dummy load to the COM antenna jack. If possible, have the pilot speak into the microphone in his normal manner. Turn the gain control fully counterclockwise. Key the transmitter and, while speaking into the microphone, adjust the gain control until the positive and negative voice peaks, viewed on the oscilloscope, begin flattening.

2. Alternate Method (Adjustment in Aircraft)
   Connect the microphone to the Mark 12B. Connect the common lead of a Simpson Model 260 VOM, or equivalent to the Mark 12B chassis. Connect the probe to the feed-thru capacitor located in the left front corner of the chassis (violet wire attached to this feed-thru). Set the VOM function selector to "output". Key the transmitter and while speaking a sustained "ah" into the microphone, adjust the gain control for a reading of 60 to 75 volts on the VOM.

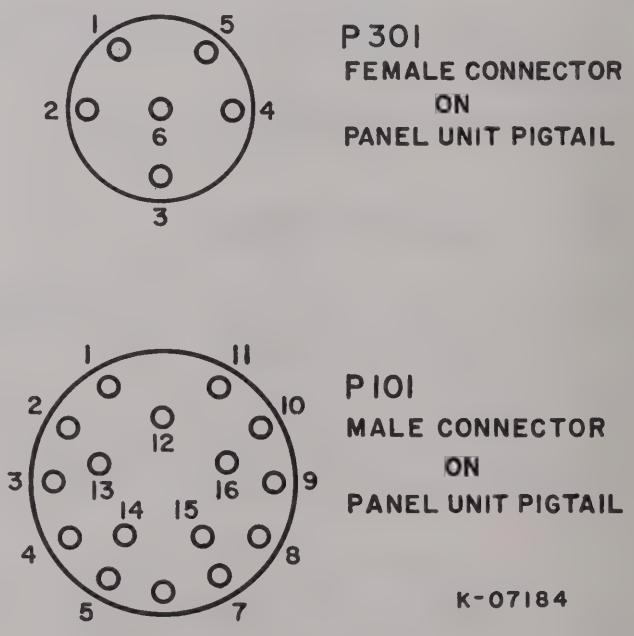
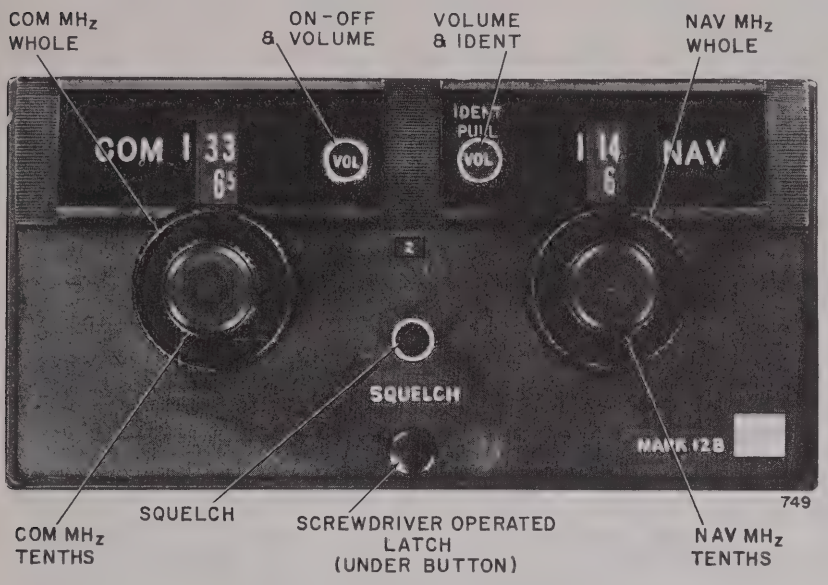


Figure 2-7 CONNECTOR PIN IDENTIFICATION



COM MHz Knob Assy	88196-0102
NAV MHz Knob Assy	88196-0103
INSERT, Blank (for above knobs)	04380-0005
SQUELCH, IDENT, ON-OFF Knobs (1/8 inch serration)	88193-0002
INSERT, Knob (VOL) (for 1/8 inch serrated knob)	04380-0003
INSERT, Knob (-) (for 88193-0002 Squelch knob only)	04367-0001
SQUELCH, IDENT, ON-OFF knobs (5/16 inch serration)	88189-0001
INSERT, Knob (VOL) (for 5/16 inch serrated knob)	04380-0001
LABEL, Unit Number 1, 2, and 3	04366-0001
TRIM PANEL ASSY (less the above)	01951-0402
LOGO, Square	04342-0001

Figure 2-8 MARK 12B FRONT PANEL

2.12 OPERATING CONTROLS

The ON-OFF switch, part of the COM volume control, is in the primary DC line. It is OFF in the full counterclockwise position. The COM volume control affects only the COM receiver. Volume increases with clockwise rotation.

The squelch control is used to cut off COM receiver output when no signal is being received. As the control is rotated counterclockwise, stronger signals are required to override the squelch circuit action.

The NAV volume control affects only the NAV receiver. Volume increases with clockwise rotation.

Pulling the NAV volume control knob defeats the built-in IDENT tone filter. Code identification may then be heard. With the knob pushed in, the 1020 Hz tone is removed.

The COM and NAV receivers are tuned by individual channel selectors. The knobs are turned until the desired frequency appears in the panel cutout above the channel selector.

The COM transmitter and receiver are tuned to the same frequency. Pressing the microphone's push-to-talk switch, activates the transmitter.

Detailed operation procedures are provided in the Operating Instructions booklet shipped with each unit.

Additional information on operating practices is provided in the FAA Airman's Information Manual.

2.13 POST INSTALLATION CHECK-OUT

After the installation has been completed, it should be operated on the ground thru the antennas with all normal power turned on and the engine(s) running. The receivers should be checked for proper operation by channeling to available signals. A ground check of the transmitter should be made to determine output and audio quality. This may be done by contacting the control tower of any other communication facility.

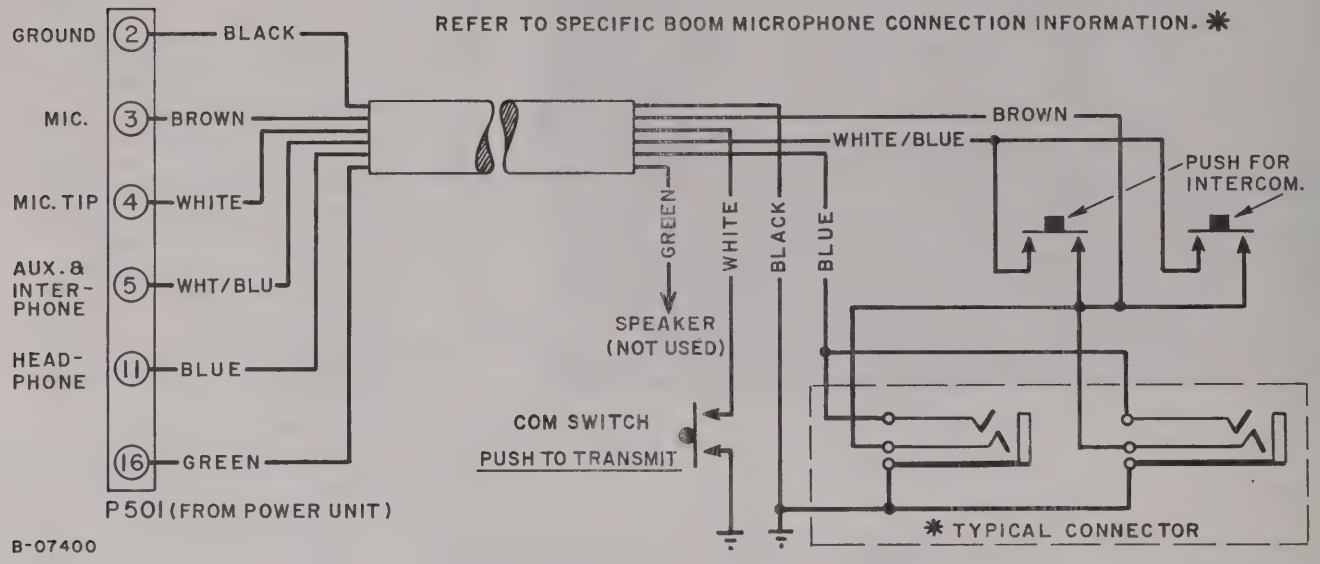


Figure 2-9 T(12/24) MP-12AH-1 WIRING DIAGRAM

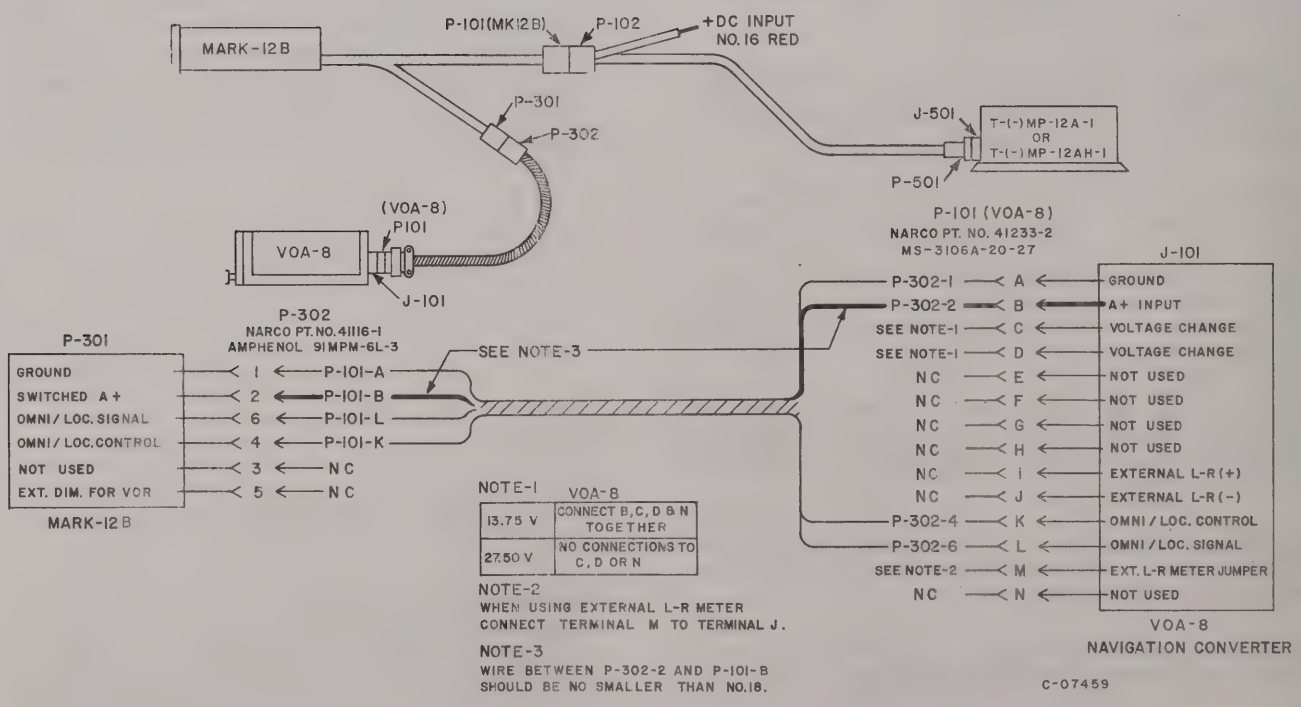
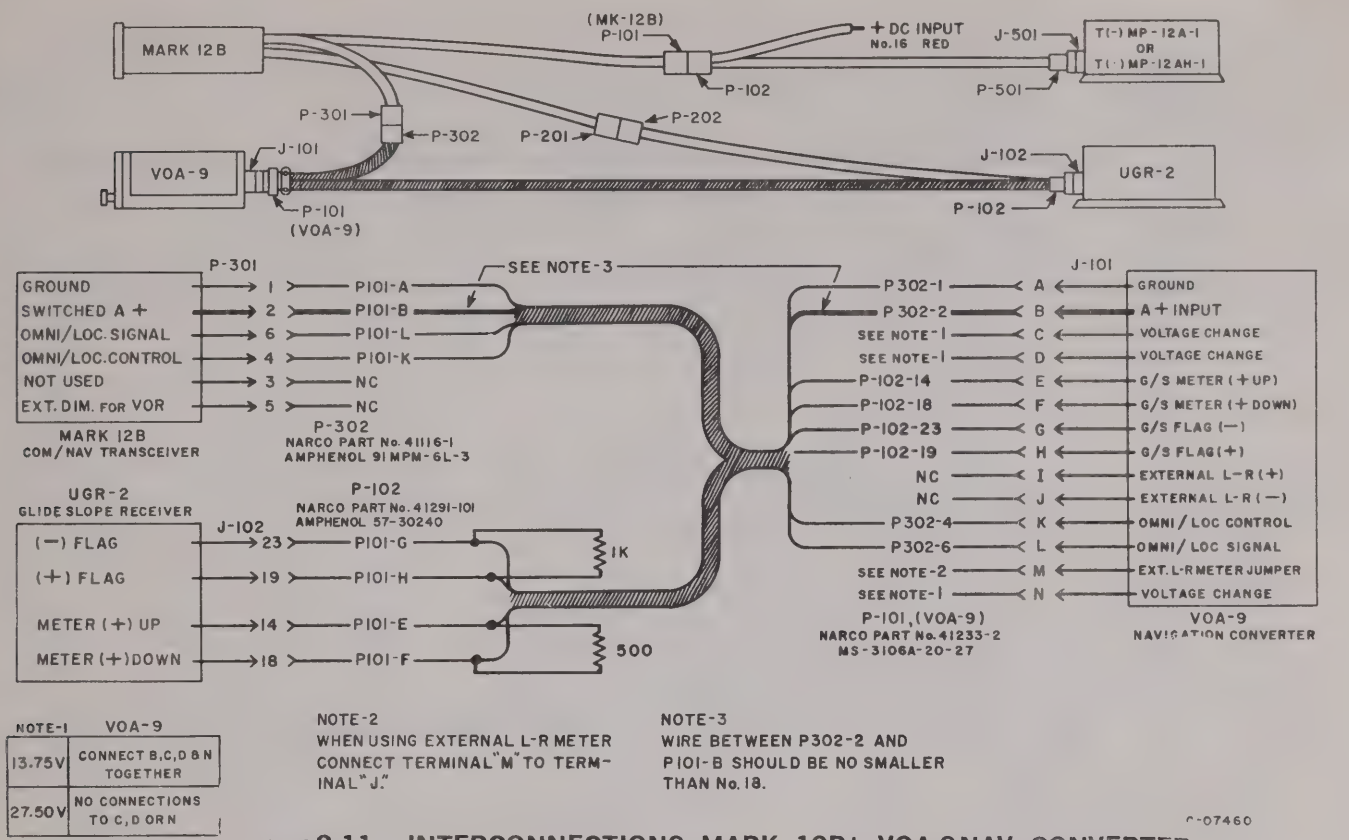


Figure 2-10 INTERCONNECTIONS MARK 12B to VOA-8 NAV CONVERTER



NOTE-1	VOA-9
13.75V	CONNECT B,C,D & N TOGETHER
27.50V	NO CONNECTIONS TO C,D OR N

NOTE-2
WHEN USING EXTERNAL L-R METER CONNECT TERMINAL "M" TO TERMINAL "J."

NOTE-3
WIRE BETWEEN P302-2 AND P101-B SHOULD BE NO SMALLER THAN No. 18.

C-07460

Figure 2-11 INTERCONNECTIONS MARK 12B to VOA-9 NAV CONVERTER

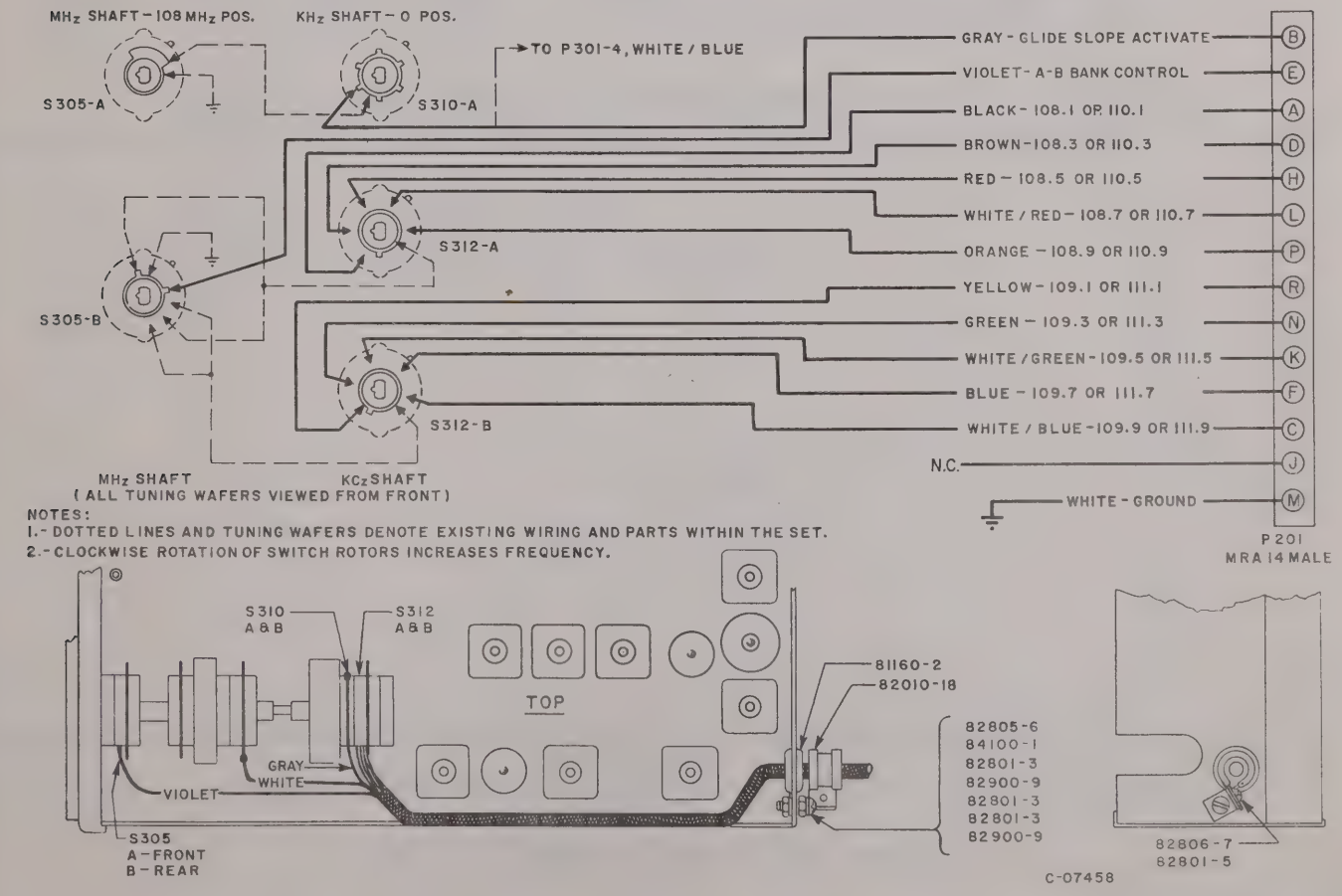


Figure 2-12 SWITCH WIRING, MARK 12B to GLIDE SLOPE CHANNEL SELECTOR

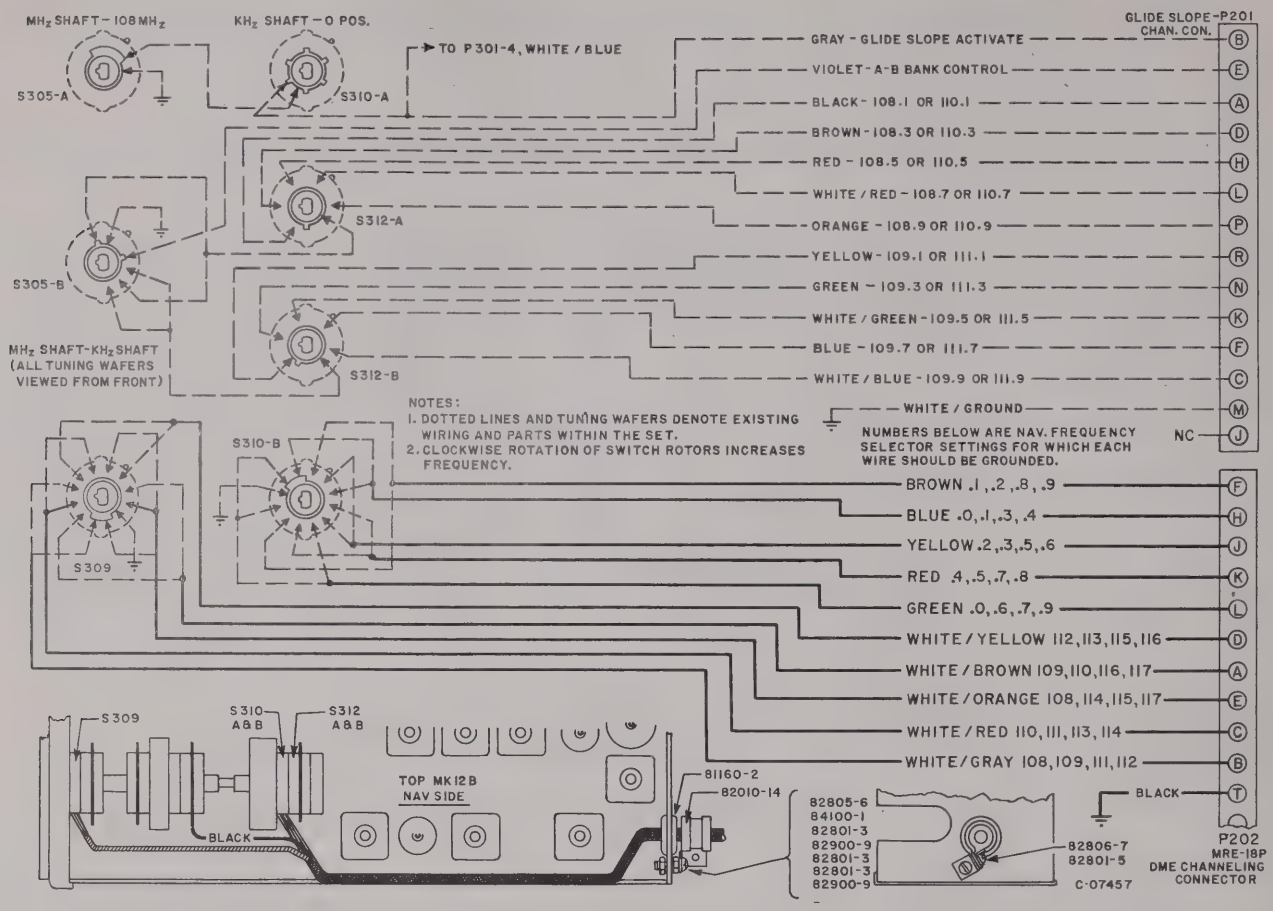
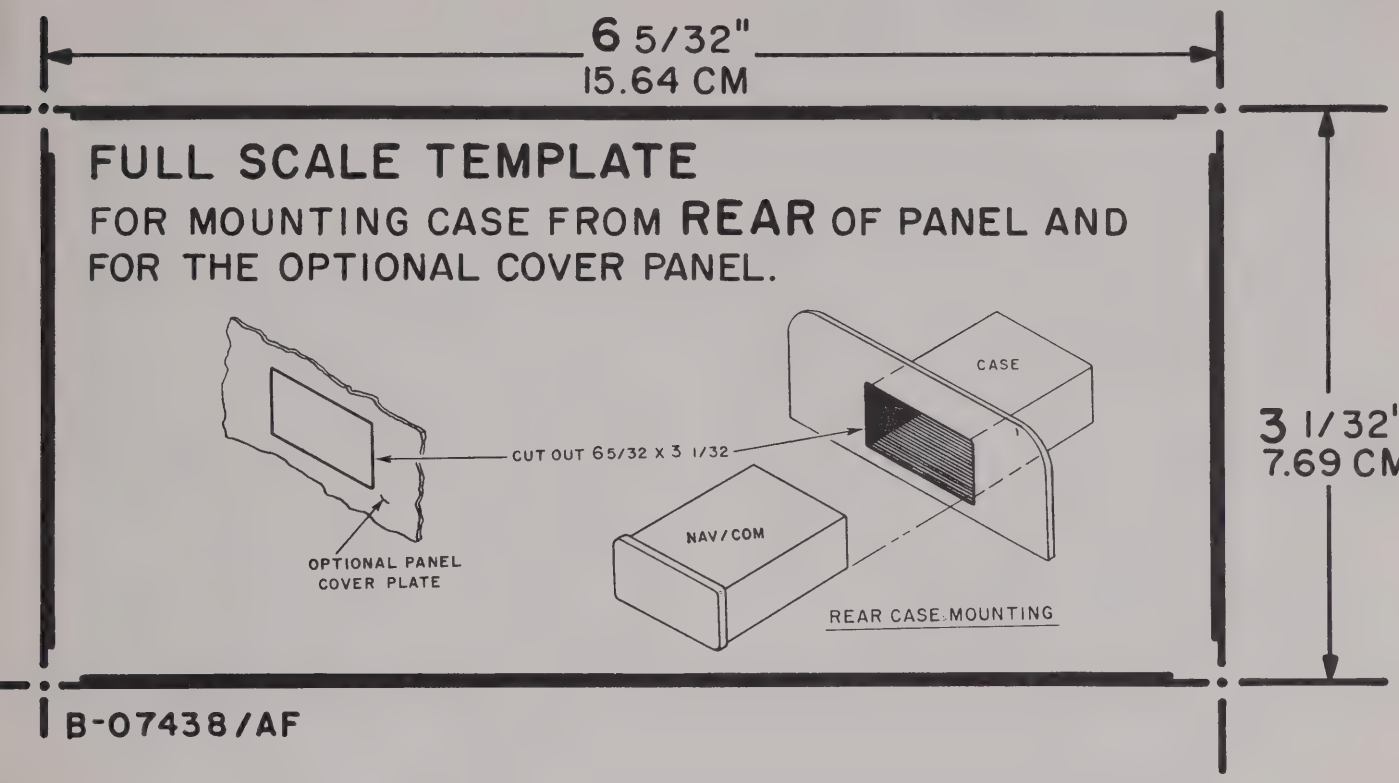


Figure 2-13 SWITCH WIRING, MARK 12B to DME CHANNEL SELECTOR



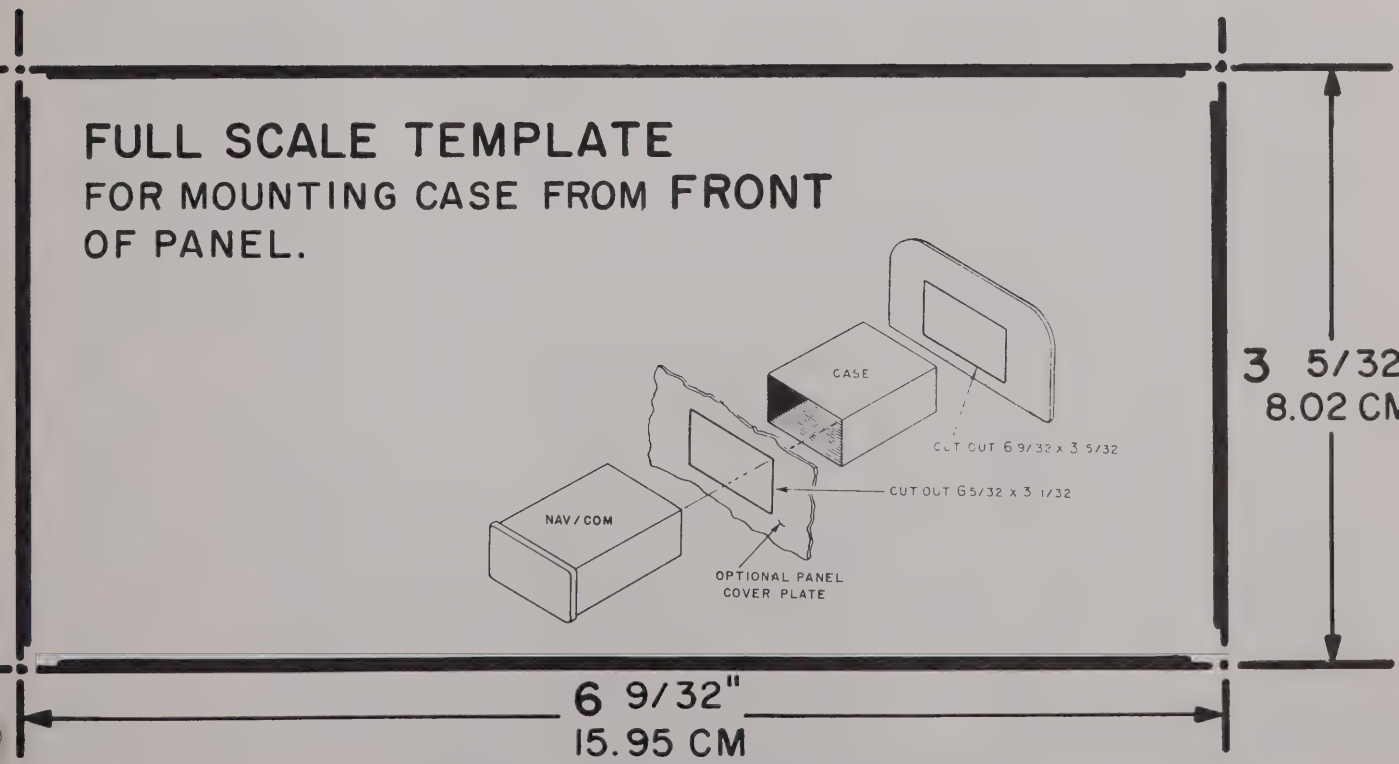
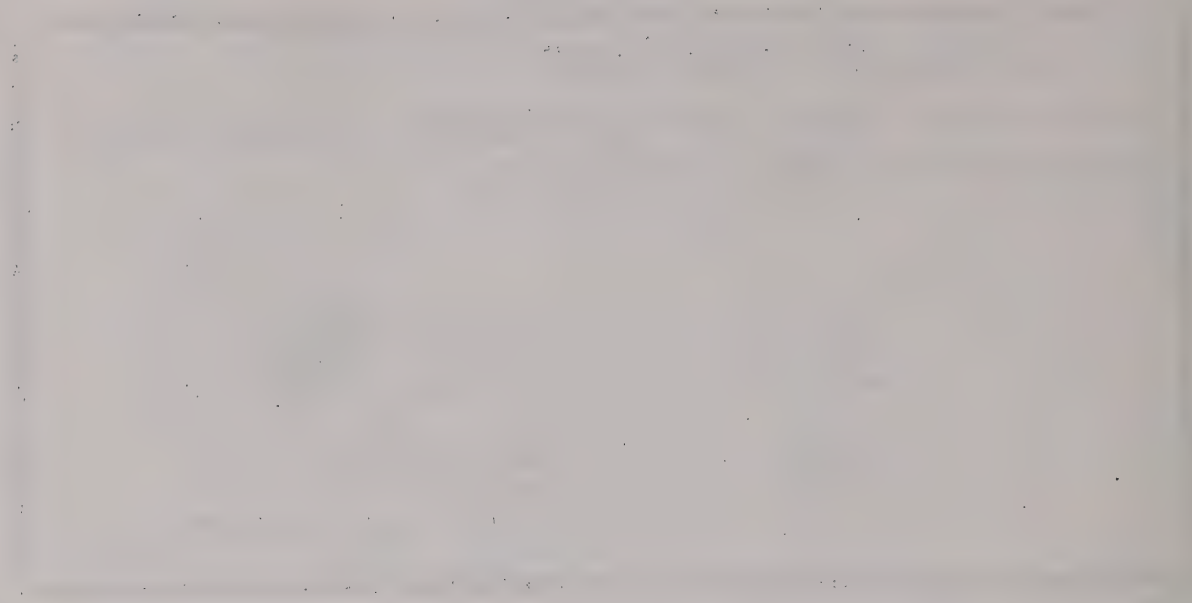
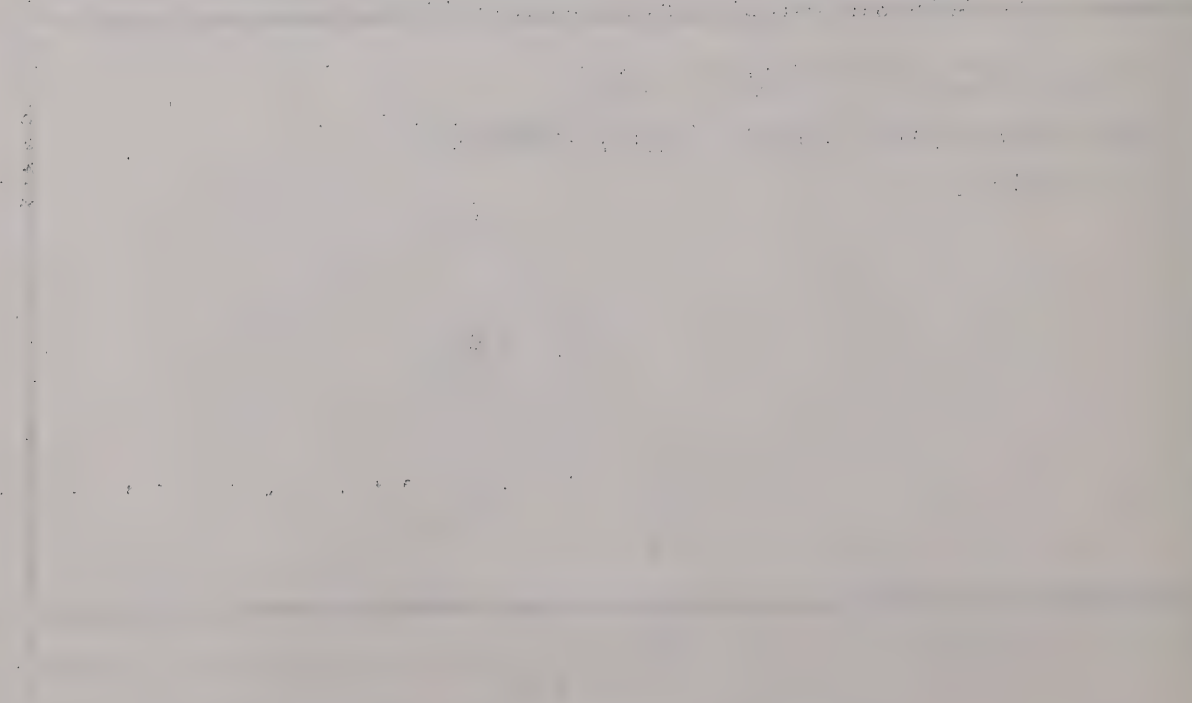


Figure 2-14 MARK 12B FRONT PANEL TEMPLATE





3.1 INTRODUCTION

This Section describes the circuitry of the Mark 12B and the Modulator-Power Unit.

3.2 MARK 12B PANEL UNIT

The Panel Unit contains two major items, a communication Transceiver and a Navigation Receiver. The Transceiver consists of a VHF Transmitter and Receiver providing simplex communication on either 90 or 360 crystal controlled channels. The Navigation Receiver has 100 channels for OMNI Navigation and ILS LOCALIZER service. Separate connectors are provided for Communication and Navigation Antennas.

The Panel Unit may be operated on a nominal DC supply voltage of either 14 or 28 volts, depending on a few simple connection changes on a terminal strip. See Figure 2-6.

3.3 COMMUNICATION TRANSCEIVER

3.3.1 Oscillators

The communication transceiver consists of a VHF transmitter and receiver tuned to the same frequency by one set of frequency selector knobs. It provides simplex operation on 90 or 360 crystal controlled channels in the domestic model, and on 100 or 360 channels in the export model.

TABLE 3-1

CRYSTAL FREQUENCY — HFO
COMMUNICATION TRANSCEIVER

Channel	Oscillator Fundamental Frequency (MHz)	Oscillator Doubler Frequency (MHz)
117	63.2375	126.475
118	63.7375	127.475
119	64.2375	128.475
120	64.7375	129.475
121	65.2375	130.475
122	65.7375	131.475
123	66.2375	132.475
124	66.7375	133.475
125	67.2375	134.475
126	67.7375	135.475
127	68.2375	136.475
128	68.7325	137.475
129	69.2375	138.475
130	69.7375	139.475
131	70.2375	140.475
132	70.7375	141.475
133	71.2375	142.475
134	71.7375	143.475
135	72.2375	144.475

The COM high frequency oscillator (HFO) is a crystal stabilized Colpitts circuit using fifth overtone crystals in the 63 through 73 MHz range. The HFO transistor Q-202, is a UHF silicon transistor which provides stable operation over a wide temperature range. The collector circuit of Q-202 is tuned by C-247, C-248, C-249, C-25l, and L-218 with a step inductor, L-219, which adjusts the tank to resonance at each frequency. Feedback is applied to the oscillator emitter through the crystal which operates in its series mode. The choke across the crystal, L-221, is parallel resonant with the crystal holder capacitance in the oscillator frequency range. It prevents free running oscillation chould a crystal fail.

HFO output is coupled through C-266 to the base of Q-201, the HFO doubler. Q-201 is biased near cutoff, and its collector tank is tracked to tune at twice the oscillator frequency. It therefore doubles the HFO frequency. The doubler output frequencies range from 126 to 145 MHz. Table 3-1 gives the oscillator and doubler frequencies for each whole megahertz position.

The COM low frequency oscillator (LFO) is a crystal controlled Colpitts oscillator operating in the 8.5 to 9.5 MHz range. For any communication channel, the LFO frequency for transmitting is always removed .500 MHz from the frequency for receiving. Table 3-2 gives the transmit and receive crystal frequencies for each fractional megahertz channel.

TABLE 3-2

CRYSTAL FREQUENCY — LFO
COMMUNICATION TRANSCEIVER

Channel	Transmit Crystal Frequency (MHz)	Receive Crystal Frequency (MHz)
.00	9.475	8.975
.05	9.425	8.925
.10	9.375	8.875
.15	9.325	8.825
.20	9.275	8.775
.25	9.225	8.725
.30	9.175	8.675
.35	9.125	8.625
.40	9.075	8.575
.45	9.025	8.525
.50	8.975	9.475
.55	8.925	9.425
.60	8.875	9.375
.65	8.825	9.325
.70	8.775	9.275
.75	8.725	9.225
.80	8.675	9.175
.85	8.625	9.125
.90	8.575	9.025
.95	8.525	9.025

Switches S-204 and S-220 are attached to one rotor, and always select two crystals separated by .500 MHz. Diodes CR-201 and CR-202 select the proper crystal for transmitter or receiver operation. The anodes of both diodes are biased at about +30 volts through R-227, which is attached to the +160V constant line. During transmission periods, the cathode of CR-201 is raised to about 50 volts by voltage divider R-228 and R-230, from the +150V transmit line to ground. CR-201 is therefore reversed biased. CR-202, however, conducts through R-231 and presents a low impedance path from the transistor base to S-204. In the receive mode the situation is reversed. CR-202 is reversed biased by voltage from the +160V receive line, while CR-201 conducts and connects S-220 to the transistor, LFO output is taken from the emitter of Q-204. (See Figure 3-1.)

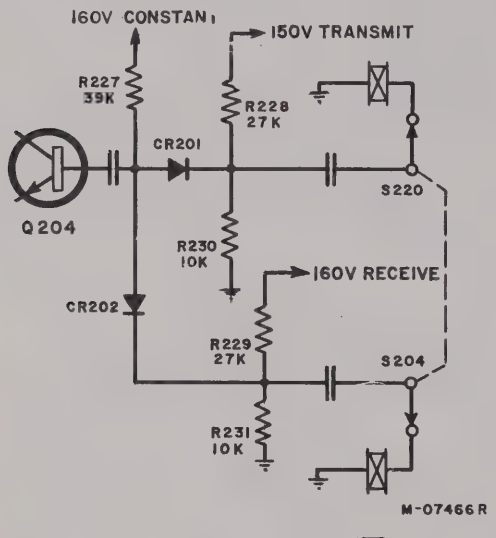


Figure 3-1 COM LFO DIODE SWITCHING

3.3.2 Communication Transmitter

The desired transmitter frequency is generated by V-204, a 6AR8 beam-deflection balanced mixer. C-238 couples energy from the HFO doubler to the control grid of the mixer. Q-203 amplifies LFO energy. T-201, a broad-band tuned transformer, steps the amplified LFO signal up to the voltage needed to drive the mixer deflection plates.

The plate load for the mixer is a balanced circuit tuned to the transmitting frequency. Much of the tuning capacitance is in the two pieces of shielded cable connecting the mixer plates to L-214 and step inductor L-212. This balanced circuit suppresses doubled HFO energy which is applied to the mixer unbalanced. LFO energy although applied to the mixer in a balanced fashion, is far enough removed from the transmitting frequency to be adequately attenuated by the transmitter tuned circuits.

The transmitter consists of three amplifiers, V-201, V-202, and V-203. They are coupled to each other and to the antenna by tracked pi-networks. A low pass filter, consisting of L-101, L-102, C-101, C102, and C-103, attenuates harmonics of the transmitting frequency. L-116 and C-170 form a series resonant trap to further attenuate LFO energy.

3.3.3 Communication Receiver

The communication receiver is a double conversion superheterodyne receiver using a tracked high frequency IF and a fixed low frequency IF. The signal from the antenna is fed to the RF amplifier, V-101, through the transmit-receive switch, CR-101.

In the receive mode, CR-101 is forward biased by voltage from the +160V transmit line applied through R-101. The diode then presents a low impedance to RF signals. When transmitting, the +160V receive voltage is removed, and negative voltage from the control grid of the transmitter final amplifier, V-201, is applied to the diode through R-204 and R-101 to reverse bias the diode. In this "off" state, the diode prevents transmitter energy from blocking or damaging the receiver.

The VHF signal is amplified by V-101 and coupled by the tuned circuit to the first mixer, V-102. Doubled HFO energy is also applied to this tube through C-120. The doubled HFO frequency is 8.5 to 9.5 MHz higher than the received signal frequency. The two signals mix in V-102 to produce an intermediate frequency in the 8.5 to 9.5 MHz range.

The intermediate frequency signal is coupled to the second mixer by three coupled tuned circuits. The first two branches are inductively coupled by T-101, and the second and third branches are bottom-capacitance coupled by C-130. Since the doubled HFO frequency is constant for all twenty fractional megahertz channels associated with any whole megahertz channel, there are twenty possible intermediate frequencies. The high frequency IF circuits are tuned to these twenty frequencies by step inductors L-109, L-110, and L-111, which are driven by the fractional megahertz selector knob.

The high frequency IF signal is applied, along with the COM LFO signal, to the control grid of the second mixer V-103-A. The LFO frequency is always .500 MHz removed from the high frequency IF frequency. For the .00 through .45 fractional megahertz positions, the LFO frequency is .500 MHz lower than the high frequency intermediate frequency. For the 50 through .95 positions the LFO frequency is .500 MHz higher than the high frequency intermediate frequency.

The two signals mix in V-103-A to produce a .500 MHz low frequency intermediate frequency. This signal is amplified by V-104 and Q-101, then detected by CR-102.

The voltage divider formed by the 150K ohms and 560 ohms resistors in CP-101 holds point A at approximately 0.5 volt above ground. As long as no current flows through the 470K resistor point B is at the same potential as point A. Detector current flow through the 120K and 82K resistors causes points C and D to be more negative than point A and B. These potentials are used as AGC. AGC from point C is at a lower level than that at point D. That from point C is applied to V-101 which, being a sharp cut off pentode, would be cut off by the higher potential at point D.

The voltage developed across the 120K resistor by detector current flow forward biases CR-103, the COM noise limiter. CR-103 then presents a low impedance to audio signals which appear across volume control R-125. The 2000 pf capacitor is a relatively high impedance at audio frequencies. The high frequencies of a noise pulse accepts the 2000 pf capacitor, C-142 and C-155 as a low impedance to ground. The voltage across these three capacitors cannot change rapidly enough to follow a noise pulse so the forward bias on CR-103 is reduced for duration of the pulse The diode then presents a high impedance to audio signals reducing the level of noise signals.

CR-104 is the squelch gate. The anode of this diode is biased by the screen grid potential of V-104, applied through R-130. The screen potential varies with AGC variations. It is lowest under no-signal conditions when tube current is high. The cathode potential of CR-104 is set by R-132, the squelch control. If the cathode potential is greater then the screen voltage, the diode is reverse biased, and the audio signal is blocked. R-132 is set to reverse bias CR-104 under no-signal conditions. When a signal is received, AGC voltage is developed. The screen voltage increases and the diode is forward biased, so it passes the audio signal.

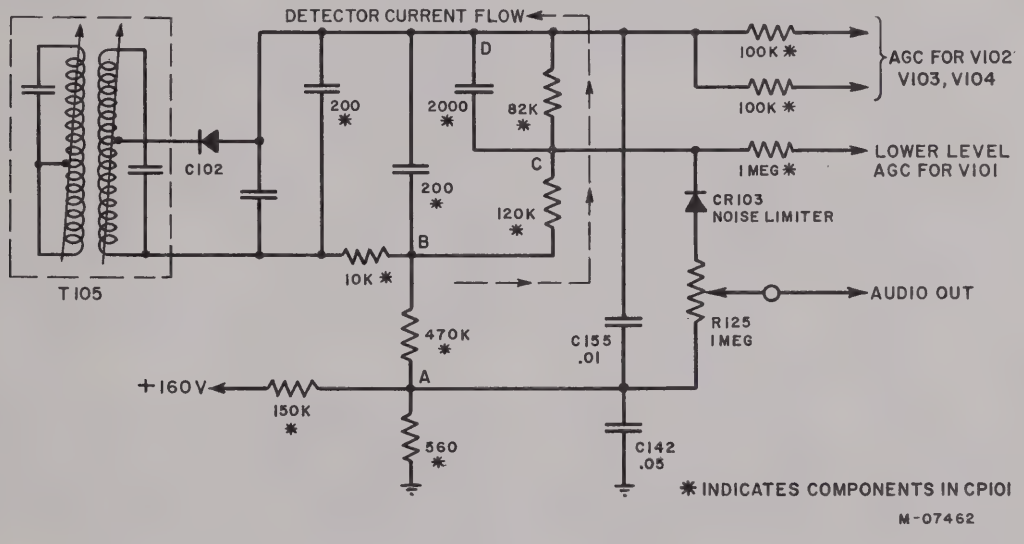


Figure 3-2 COM DETECTOR SCHEMATIC

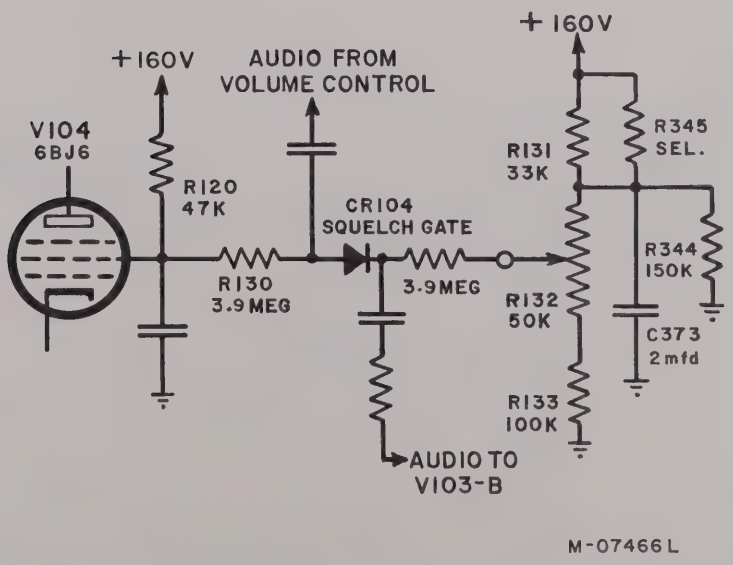


Figure 3-3 SQUELCH GATE SCHEMATIC

3.4 NAVIGATION RECEIVER

The Navigation Receiver is a dual conversion superheterodyne receiver employing a tracked high frequency IF and a fixed low frequency IF. The VHF signal from the antenna is coupled by L-301 and C-301 to the RF amplifier, V-301. It is amplified and coupled by a double tuned circuit to the first mixer, V-302, where is it mixed with the high frequency oscillator output.

The high frequency oscillator is a crystal stabilized, modified Colpitts circuit. Feedback to sustain oscillation is applied through fifth overtone type crystals. The frequency of oscillation is therefore stabilized at the series resonant frequency of the crystal. The A + voltage for the oscillator transistor, Q-301, is stabilized by a zener diode for frequency stability.

The high frequency oscillator operates in the 96 through 106 MHz range. Its frequency is set by the NAV whole megahertz selector. Table 3-3 gives the oscillator frequency for each channel.

The plate circuit of V-302 is tuned to the difference between the incoming VHF and the high frequency oscillator frequencies. This high frequency intermediate frequency is different for each setting of the fractional megahertz selector. The high frequency IF transformer, T-301, is tuned for each different frequency by L-307 and L-308. These step inductors are controlled by the fractional megahertz selector.

The high frequency IF signal is mixed with the low frequency oscillator signal in the second mixer, V-303. The low frequency oscillator, V-304, is a Colpitts circuit operating in the 10.3 to 11.3 MHz range. It is inductively tuned by step inductor L-315, which is operated by the NAV fractional megahertz selector. The LFO frequency is always 1.125 MHz lower than the high frequency IF. Table 3-4 gives the oscillator frequency for each channel.

The difference frequency between the HF IF and the LFO frequency, 1.125 MHz, is selected by T-302 and amplified by Q-302 and Q-303. T-302 is overcoupled to provide the necessary bandwidth.

The second IF amplifier Q-303 output is coupled through T-303 to the detector circuit. The operation of this output transformer is unusual; therefore, a simplified eqivalent operational circuit is given in Figure 3-4 and explainined in detail below. Transformer T-303 is runed as follows: (a) primary is parallel resonant and (b) secondary is series resonant with C-334, providing the voltage step-up required for proper OMNI and localizer operation. The primary is adjusted for parallel resonance which presents a high impedance to the Q-303 collector circuit. The secondary is adjusted for series resonance, which serves to step-up the signal voltage to the detector. The tune-up procedure differs from that for alignment of other IF transformers. Refer to paragraph 4.7.1 for alignment instructions.

As shown in Figure 3-5, detector current flowing through CR-301, the secondary of T-303, and the 150K and 180K resistors forward biases CR-303. C-336 prevents the potential at the cathode of CR-303 from changing very rapidly, although it can follow audio frequencies to slightly over 2000 Hz. The cathode cannot follow a fast noise pulse. Noise pulses therefore, drive the anode of CR-303 negative with respect to the cathode. The diode is then biased off and presents a high impedance to audio signals for the duration of the noise pulse.

CR-302 sets the AGC threshold. Under low signal conditions, CR302 is forward biased by potential from the +160 V, constant line through R-315. The AGC line is therefore slightly above ground potential. As the signal level increases the negative voltage at the detector load reverse biases CR-302, and the negative AGC voltage is applied to the tubes.

TABLE 3-3
CRYSTAL FREQUENCY — HFO
NAVIGATION RECEIVER

Channel	Crystal Frequency (MHz)
108	96.55
109	97.55
110	98.55
111	99.55
112	100.55
113	101.55
114	102.55
115	103.55
116	104.55
117	105.55

TABLE 3-4
CRYSTAL FREQUENCY—LFO
NAVIGATION RECEIVER

Channel	Frequency (MHz)
.0	10.325
.1	10.425
.2	10.525
.3	10.625
.4	10.725
.5	10.825
.6	10.925
.7	11.025
.8	11.125
.9	11.225

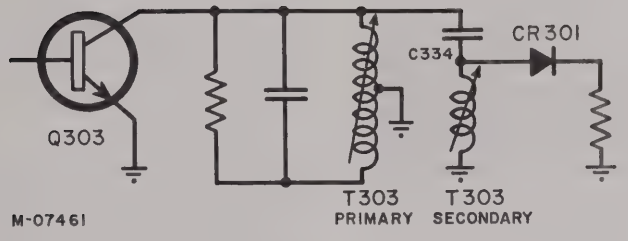


Figure 3-4
IF TRANSFORMER T-303, EQUIV. COUPLING CIRCUIT

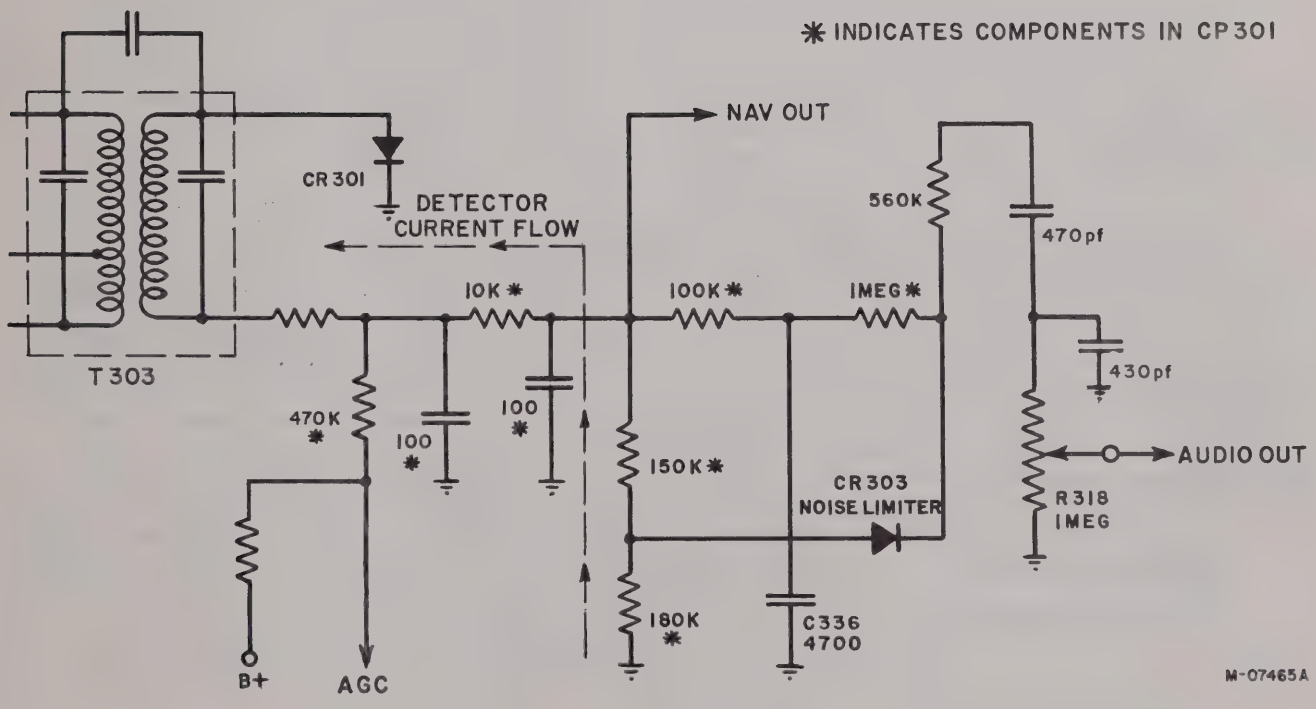


Figure 3-5 NAV DETECTOR SCHEMATIC

3.5 MODULATOR-POWER UNITS

The Modulator-Power Unit contains an Audio Amplifier/Modulator and a DC to DC Converter. The Audio Amplifier serves as the transmitter modulator in the transmit condition and operates the headphones and loudspeaker in the receive condition. The DC to DC Converter changes the primary DC supply to the DC voltages required by the various circuits.

The Modulator-Power Units are not convertible from one primary DC voltage to another. There are four types available. The T(12)MP-12A-1 and the T(12)MP-12AH-1 are to be used on a nominal 14 volt DC supply and the T(24)MP-12A-1 are the T(24)MP-12AH-1 are to be used on a nominal 28 volt DC supply.

A gain control in the microphone input may be adjusted for full modulation with inputs of .06 to 0.5 volts from a 100 ohm source. This control is preset at the fratory for carbon microphone levels.

The suffix "AH" in the Unit's designation indicates that the Unit is for helicopter application.

The "AH" units are designed to be integrated with the cyclic's communication buttons.

Most helicoptors, due to noise levels, require the use of headphones and boom mikes. It is for this reason that the cyclic is provided with two communication buttons: (1) a comm switch, (2) an intercomm switch.

K-502, R-414, and C-509 in the "AH" Units provide delay in switching, eliminating the click in the headphones caused by the collapsing field in the Power Unit output transformer. The side-tone level has been adjusted with proper modulation level for listening comfort during transmission. Figure 3-6, illustrates the intercom circuit.

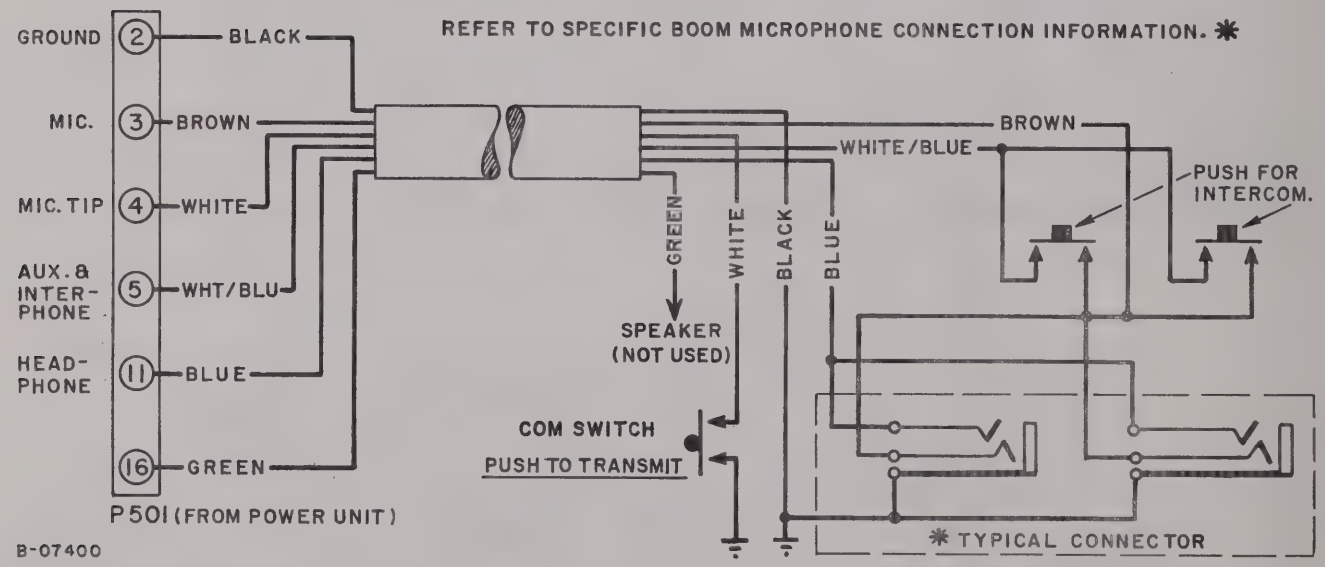


Figure 3-6 T(12/24) MP-12AH-1 WIRING DIAGRAM

3.5.1 Power Circuits

The power supply section uses two power transistors, Q-501 and Q-502, and a power transformer, T-501, in a circuit whose simplified operation is as follows. The instant primary voltage is applied (A+), because of the inevitable dissimilarity of the two transistors more current will flow in one than in the other. This greater flow of current through the feedback windings of the power transformer induces a voltage on the transistors such that the conducting unit is driven into greater conduction and the other is held at cut-off.

Almost instantly the transformer reaches saturation. Thus having reached maximum flux density, there is no more induced voltage in the bias windings which are connected to the transistor circuitry. Therefore, the current through the conducting transistor decreases, and bias voltage at opposite polarity is developed which cuts off this transistor and simultaneously causes the second transistor to conduct. The same procedure repeats with the second transistor. This switching action repeats at high speed and the resultant output voltage of T-501 is essentially a square wave.

A full wave bridge rectifier consisting of CR-501, CR-502, CR-503, and CR-504 in conjunction with the center tapped secondary of T-501 provides a simple means of obtaining a dual voltage output. Filtering of these DC voltages is easily accomplished because of the high frequency of the power supply.

3.5.2 Panel Unit Audio Circuits

Audio signals from the two volume controls are combined in CP-302, then applied to the grid of the first audio amplifier, V-103-B. The amplified audio signal at the plate of V-103-B is applied to the base of Q-304 through a parallel tuned filter consisting of C-340 and L-317. This filter is tuned to 1020 cps. It presents a high impedance at this frequency to provide approximately 20 db rejection of the code identification tone transmitted by navigation stations. S-313, the push-pull switch attached to the NAV volume control, shorts out the filter when pulled. This permits the pilot to hear the code identification. When the knob is pushed in the tone is reduced to make voice transmissions more understandable. Q-304 is an emitter follower providing an impedance match to the audio power amplifier.

3.5.3 Audio Circuits ("A-1" Series)

The remainder of the audio circuit is located in the modulator/power unit. In the receive mode, the audio signal from Q-304 is switched by K-501 to the base of Q-401, the audio driver. The audio output is switched by K-501 to the speaker output lead, and is applied at all times to the headphone lead.

In the transmit mode, audio signal from the microphone is switched by K-501 to the base of Q-401. Audio output is taken from the modulation winding of T-402. In this case, K-501 switches B+ to the modulation winding to activate the transmitter.

3.5.4 Audio Circuits (AH-1 Series)

The audio circuits in the Modulator-Power Unit contains an additional time delay relay (K-502), incorporated in the speaker and phone output leads. The remainder of the circuit is unchanged.

In the transmit mode, relay K-503 activates relay K-502 and capacitor C-509, (which is across relay K-502's windings) begins to charge. When the transmitter is un-keyed, the charge on C-509 keeps K-502 closed for approximately 20 milliseconds, allowing the inductive kickback of the audio output transformer modulation secondary (T-402) to bleed off, thus preventing a loud unpleasant noise in the phones or speaker. Resistor R-413 is wired across contacts 3 and 5 of relay K-502 so that in the transmit mode, a headphone sidetone signal is provided.

4.1 INTRODUCTION

This Section, Maintenance and Service Procedures, provides support for the MK-12B in five major areas: Mechanical, the removal and replacement of components; Electrical, adjustment and alignment; Modulator-Power Unit adjustment methods; the procedure used to convert a 90 channel Unit to 360 channels; and how to select electrical "selected components".

4.1.1 Panel Unit Connections.

The Panel Unit has a short cable with two branches extending from the rear. The smaller branch has a 6 circuit connector which may connect directly or via an extension cable via an adaptor cable to a NARCO VOA-8, VOA-9 or VOA-40/50 Series Navigation Converter. The larger branch has a 16 circuit connector to accommodate the connector and cable for the Modulator-Power Unit and the connections to the primary DC power and accessories.
If a glide slope receiver or DME interrogator is controlled by the NAV receiver channel selectors, there will be one or two additional cables extending from the rear of the panel unit.
For details of these interconnections see illustrations in Section 2.

4.1.2 Replacement Parts.

Table 4-1 lists the recommended spare parts for the Mark 12B. In some cases, realignment may be necessary after replacing a part. V-204 is specially constructed for electrical balance. It should, if possible, be replaced with one obtained from NARCO. Most of the transistors and diodes are manufactured to NARCO specifications. The commercial replacements listed are not exact equivalents, and should be used only if absolutely necessary.

4.2 MECHANICAL MAINTENANCE

4.2.1 Panel

The Panel Unit Case is normally installed permanently in the aircraft. To remove the unit, it is only necessary to disconnect the cables at the rear of the chassis and release a single fastener located under the "button" on the front trim panel. The unit may then be withdrawn from the front of the case.

The open frame chassis design is such that practically every component, except the ones in the three small shielding compartments, is readily accessible as soon as the unit is withdrawn from the case. Disassembly and reassembly of the COM and NAV Channel Selectors is somewhat involved, but detailed instructions for the procedure are given in paragraphs 4.2.4 through 4.2.ll.

The components in the three small shielding compartments are made accessible by removing the covers, which are held in place by small screws. The two compartments near the center of the chassis have both top and bottom covers.

A certain sequence of replacing the covers of the center compartments is helpful. The bottom cover on the left center (COM side) may be removed and replaced without disturbing the top cover. However, if the top cover is removed, it will be easier to remove the bottom cover before reassembly of the top cover. Once the top cover is in place, the bottom cover may be reassembled without difficulty.

NOTE: The bottom cover fits *inside* the top cover.

The top cover on the right center compartment (NAV side) may be removed and replaced without disturbing the bottom cover. However, if the bottom cover is removed, it will be easier to first remove the top cover before reassembly of the bottom cover.

The remaining compartment at the bottom left front (COM side) has only one cover. It is held in place by one screw at the rear flange of the cover and two tabs on the front flange of the cover. The tabs fit into slots at the front of the compartment proper.

4.2.2 Modulator-Power Unit Access.

The Modulator-Power Unit is usually installed in a remote location on a Mounting Base. The Mounting Base is normally installed permanently. To remove the Unit, it is only necessary to loosen (without removing) four mounting screws and detach the single cable connector. Access to all components is then made by removing the screws holding the two "L" shaped pieces covering the four sides.

If the Transistor Q-401 (First Audio Amp.) is removed, care must be exercised to prevent damaging the insulator under the mounting, and to replace it properly.

4.2.3 Periodic Service.

The only item which may require occasional attention is the COM Fractional MHz Channel Selector Detent Assembly, near the rear of the chassis. It consists of a star wheel, roller, and detent fulcrum, which should be lubricated with wide temperature range grease. It is recommended that this assembly be checked whenever the Unit is removed for maintenance.

Table 4.1 RECOMMENDED SPARE PARTS

Item	Total Quantity	NARCO Part No.	Commercial Replacement
DIODES			
CR-101	1	75013-5	CD 12227
CR-102	2	75019-2	CD 6487
CR-301			
CR-103	4	75013-4	CD 12226
CR-104			
CR-302			
CR-303			
CR-105	1	75025-2	
CR-201	2	75021-2	
CR-202			
CR-501	6	75204-45	
CR-502			
CR-503			
CR-504			
CR-505			
CR-506			
FUSES			
F-501 (14V)	1	66504-12	Fuse, 10A, SLO/BLO
F-501 (28V)	1	66504-10	Fuse, 6¼A, SLO/BLO
LAMPS			
I-101	2		Lamp, No. 53, Red
I-102			
TRANSISTORS			
Q-101	5	75568-2	
Q-201			
Q-202			
Q-301			
Q-303			
Q-203	4	75550-7	2N3391
Q-204			
Q-302			
Q-304			
Q-305	1	75578-1	MPF103
Q-401	1	75534-4	2N376A (hfe ≅ 120 to 160)
Q-402 (14V)	2	75534-3	2N376A (hfe ≅ 100 to 130)
Q-403 (14V)			
Q-402 (28V)	2	75511-3	2N1136B
Q-403 (28V)			
Q-501 (14V)	2	75548-3	2N441
Q-502 (14V)			
Q-501 (28V)	2	75505-3	2N174
Q-502 (28V)			
TUBES			
V-101	1	6BH6	6BH6
V-102	1	6AK5	6AK5
V-103	1	6EA8	6EA8
V-104	2	6BJ6	6BJ6
V-301			
V-201	1	7551	7551
V-202	2	8106	8106
V-203			
V-204	1	75401-1	6AR8 (Special)
V-302	2	6CB6	6CB6
V-3023			
V-304	1	6CW4	6CW4

4.2.4 Channel Selector Knob, Dial and Shaft Removal, Replacement and Positioning.

The procedures for disassembly and reassembly of the Channel selectors given in paragraphs 4.2.5 through 4.2.9, give a procedure which should maintain the proper relations among the Knobs, Dials, Shafts, and Switch Section Rotors and Stators. If these relations become misarranged for any reason the correct relations may be reestablished according to the 4.2.10.

NOTE: In the succeeding paragraphs through 4.2.11, all references to mechanical position such as top and bottom, left and right, front and rear as viewed facing the front of the Panel Unit in an upright position.

4.2.5 COM Fractional MHz Shaft, Removal and Replacement.

Removal Procedure:

a. Remove detent spring and roller which engages the star wheel assembly at the left side rear of the set on the COM, Fractional MHz Shaft and then loosen the two setscrews in the star wheel assembly.

b. Rotate the COM MHz Knob to the 118 position, the COM Fractional MHz Dial to the 0.3 position, and the NAV MHz Knob to the 108 position and the NAV Fractional MHz Dial to the 0.6 position.

CAUTION: If the knobs and dials are not set as indicated, the switch sections may be damaged, when the shafts are removed as described under step g.

c. Loosen setscrews and remove from the unit both volume knobs, squelch knob, and both whole megahertz knobs.

d. Loosen and remove the four screws at the corners of the trim panel. The panel can now be removed by pulling it forward from the unit.

e. Loosen setscrews in both fractional megahertz knobs and in both whole megahertz dials. Setscrews in the dials are accessible when the fractional megahertz knobs are rotated to line up access holes.

f. Front of chassis is now exposed. On the left hand side is the COM MHz detent. Remove its screws, nuts, lockwashers, and the spacers which retain the detent assembly to the front of the chassis.

g. Note that it is necessary to remove the COM MHz Shaft in order to remove the COM Fractional MHz Shaft. Both COM MHz Shaft and detent assembly and COM Fractional MHz Shaft can now be withdrawn simultaneously from the front of the chassis.

Replacement Procedure: Follow the Removal Procedure in reverse.

4.2.6 COM Whole MHz Shaft and Detent Assembly, Removal and Replacement.

Removal Procedure:

Follow instructions described in Removal Procedure 4.2.5 but omit step a. and step g. The COM MHz Shaft and Detent Assembly can now be withdrawn from the front of the chassis without disturbing the COM Fractional MHz Shaft and Detent.

Replacement Procedure:

Follow the Removal Procedure in reverse.

4.2.7 NAV Whole MHz Shaft and Detent Assembly, Removal and Replacement.

Removal Procedure:

a. See Removal Procedure 4.2.5, and perform steps b., c., d., and e.

b. After these steps have been completed, the front of the chassis will be exposed and on the right hand side will be the NAV MHz Shaft and Detent Assembly. This can then be removed by loosening and removing the two mounting nuts and lockwashers at the rear of the variable inductor and crystal switch section assembly.

c. In the same area remove the hairpin retainer from the NAV MHz Shaft.

d. On the front of the chassis the two long strut screws can now be removed, but be careful to note the location of the two metal spacers in the wafer assembly.

e. The NAV MHz Detent and Shaft Assembly can now be withdrawn from the front of the chassis.

Replacement Procedure:

Follow the Removal Procedure in reverse.

4.2.8 NAV Fractional MHz Shaft, Removal and Replacement.

Removal Procedure:

a. Position the NAV Fractional MHz Dial to 0.6. Then loosen the setscrew which is seated the deepest in the NAV Fractional MHz Knob and remove the knob and its bushing from the Unit.

b. Loosen the two setscrews in the hub of the NAV Fractional MHz Dial.

c. At the rear of the LF Oscillator, glide slope, and variable inductor switch sections, there is a detent rotor assembly. Loosen the two setscrews in the detent rotor assembly and also remove the hairpin retainer on the NAV MHz Shaft in front of the LF Oscillator Assembly.

d. In the rear panel there is a clearance hole provided to facilitate the removal of this shaft. Any wires interfering with this clearance hole should temporarily be carefully dressed aside.

e. Then from the front of the chassis, push in the NAV Fractional MHz Shaft flush with the front of the NAV Whole MHz Shaft. It will be seen by this operation that the NAV Fractional MHz Shaft will be protruding to the rear of the set, at the rear of the LF oscillator and switch section assembly. Continue to withdraw the shaft to the rear of the set.

Replacement Procedure:

Follow the Removal Procedure in reverse.

4.2.9 Reference Positions for Channel Selector Dials, Shafts, and Switch Sections.

a. COM Fractional Megahertz.
For the 0.5 Fractional MHz position the 3/8" diameter metal shaft flats will be in a horizontal plane, with the key notch in the Switch Section Rotors at the top.

All of the Switch Section Stators have the letter "X" stamped on the front right side adjacent to the strut screw.

b. COM Whole Megahertz.

For the 118 Whole MHz Position the 3/8" diameter glass epoxy shaft flats will be 18° clockwise from a vertical plane, with all the key notches in the Switch Section Rotors on the right side at 108° clockwise from the vertical.

The first seven Switch Section Stators have the upper right hand corner cut off. The remaining four, have the letter "X" stamped on the top front of the section.

c. NAV Whole Megahertz.

For the 108 Whole MHz position the flats on the ¼" diameter *brass* shaft will be in the same plane as the mounting strut screws in the Crystal Switch Assembly. The key notch in the eight Switch Section Rotors is on the flat toward the bottom of the Unit.

The eight Switch Section Stators have a raised key moulded on the peripheral surface, which appears at the right of the top strut screw.

d. NAV Fractional Megahertz.

For the 0.6 Fractional MHz dial position the flats on the ¼" diameter *steel* shaft shall be in the same plane as the mounting strut screws in the LF Oscillator Assembly. The key notch of the rotor in the enclosed shielded switch section (top cover removed) is on the flat toward the top of the Unit. The key notches in the four switch section rotors behind the enclosed shielded switch section, are on the flat toward the bottom of the Unit.

The switch section stator in the shielding compartment has a large cutout at the top. The remaining five stators have a raised key moulded on the peripheral surface, which appears at the right side below the upper strut screw.

4.2.10 COM Detent Spring Position, Fractional MHz, Channel Selector Switch.

When the detent star wheel assembly is installed for 10 position operation, the long end of the detent spring shall be located on the inside edge of the tab nearest the shaft.

When the detent star wheel assembly is installed for 20 position operation, the long end of the detent spring shall be located on the inside edge of the outermost tab from the shaft.

4.2.11 NAV Detent Position, Fractional MHz, Channel Selector Switch.

This detent position is not related to any particular fractional MHz position, but it must be seated when the rotor blade is centered on any stator contact. This centering may be observed on the switch section in the enclosed shielded compartment, when the top cover is removed.

4.3 ELECTRICAL MAINTENANCE.

4.3.1 Precautions.

a. Supply Voltage.

All specifications in the following sections should be met with a DC input voltage of 13.75 ot 27.5 volts, depending on the requirements of the unit being aligned. Unless a well regulated primary power supply is used, the input voltage must be adjusted to the correct value when the transmitter is keyed.

b. Duty Cycle.
Observe a 50% duty cycle when aligning the transmitter (one minute on and one minute off).

4.3.2 Equipment Required.

a. RF Power Wattmeter - Bird Termaline or equivalent.

b. VTVM - RCA Voltohmyst or equivalent, with RF probe.

c. AC VTVM - Ballentine Model 300D or equivalent.

d. Carbon Microphone.

e. Signal Generator - General Radio Model 1001A or equivalent.

f. Signal Generator - Hewlett-Packard Model 608D or equivalent.

g. Audio Wattmeter - General Radio Type 583-A or equivalent.

h. High Impedance Detector - See Figure 4-1.

i. Frequency Counter - Hewlett-Packard Model 524B or equivalent, or - BC-221-D or equivalent.

4.3.3 Alignment, 90 vs 360 Channels.

The following alignment instructions are written for the 360 channel COM transceiver. For a 90 channel unit, when instructions call for 135 MHz use 126 MHz, and when .95 is specified use .9.

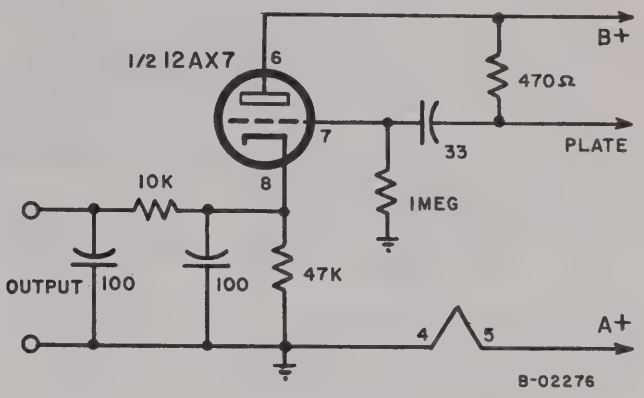


Figure 4-1
TEST DETECTOR, HIGH IMPEDANCE TYPE

4.4 COM OSCILLATORS.

4.4.1 COM High frequency Oscillator

a. Connect a RF VTVM probe to the base of Q-201, the HFO doubler.

b. Set the COM megahertz selector to 118. Adjust C-251 for maximum RF indication.

c. Set the megahertz selector to 135. Adjust L-218 for maximum RF indication.

d. Repeat steps b and c until no further increase in RF indication can be obtained.

e. Check to insure oscillator is operating in each megacycle position. Operation is indicated by a normal RF voltage reading.

Normal indication: 0.5 to 0.7 V RMS.

4.4.2 COM Low Frequency Oscillator.

a. Connect a RF VTVM probe to the emitter of Q-204, the low frequency oscillator.

b. Check to insure oscillator is operating in each fractional megahertz position. Operation is indicated by a normal RF voltage indication.

Normal indication: 2.0 to 2.5 Volts RMS.

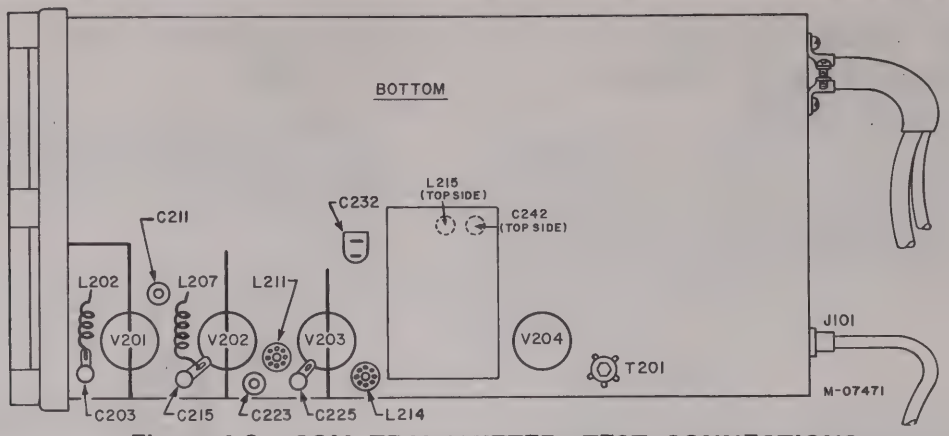


Figure 4-2 COM TRANSMITTER, TEST CONNECTIONS

4.5 COM TRANSMITTER.

4.5.1 Balanced Mixer and Buffer Alignment.

a. Connect a RF wattmeter to J-101, the COM antenna connector.

b. Connect DC VTVM probe to C-223.

c. Set the channel selector dials to 118.50 MHz. Key the transmitter and adjust T-201 for maximum negative voltage indication.

d. Key the transmitter and adjust C-242, C-232, and C-225 for maximum negative voltage indication.

e. Set the channel selectors to 135.50 MHz. Key the transmitter and adjust L-215, L-214, and L-211 for maximum negative voltage indication.

f. Repeat steps d and e until no further increase in negative voltage can be obtained.

g. Set the COM MHz selector to 135 and readjust T-201 for approximately equal negative voltage indications at the .00 and .95 fractional megahertz positions.

Normal Indication: -2 to -10 Volts DC.

4.5.2 Final Drive Adjustment.

a. Connect the DC VTVM probe to C-211.

b. Set the channel selectors to 118.50 MHz. Key the transmitter and adjust C-215 for maximum negative voltage indication.

c. Set the channel selector dials to 135.50 MHz. Key the transmitter and adjust L-207 for maximum negative voltage.

d. Repeat steps b and c until no further increase in negative voltage can be obtained.

e. Slide the panel unit into its dust jacket. Set the MHz channel selector to 118. Key the transmitter and adjust C-215 for approximately equal negative voltage indications at the .00 and .95 fractional megahertz positions.

f. Set the MHz channel selector to 135. Key the transmitter and adjust L-207 for approximately equal negative voltage indications at the .00 and .95 MHz positions.

g. Repeat steps e. and f. until negative voltage indications at the .00 and .95 MHz positions are approximately equal at 118 MHz or 135 MHz. Note that the voltage indication at 118 will generally be different from that at 135. Do not attempt to balance readings at 118 and 135 MHz.

Normal Indication: -30 to -60 Volts DC.

4.5.3 Final Amplifier Alignment.

a. Set the channel selectors to 118.50 MHz. Key the transmitter and adjust C-203 for maximum RF output power as indicated on the RF wattmeter.

b. Set the channel selectors to 135.50 MHz. Key the transmitter and adjust L-202 for maximum RF power output.

c. Repeat steps a. and b. until no further increase in power output can be obtained.

d. Slide the panel unit into its dust jacket. Set the megahertz channel selector to 118. Key the transmitter and adjust C-203 for approximately equal power indications at the .00 and .95 positions.

e. Set the megahertz channel selector to 135. Key the transmitter and adjust L-202 for approximately equal power indications at the .00 and .95 positions.

f. Repeat steps d. and e. until power indications at the .00 and .95 positions are approximately equal at the 118 or 135 position. Note that the power indication at the 118 position will generally be different from that at 135. Do not attempt to balance readings at the 118 and 135 positions.

Normal Indication: Lower frequency 50% of total channels - 9.0 watts minimum.

Higher frequency 50% of total channels - 7.0 watts minimum.

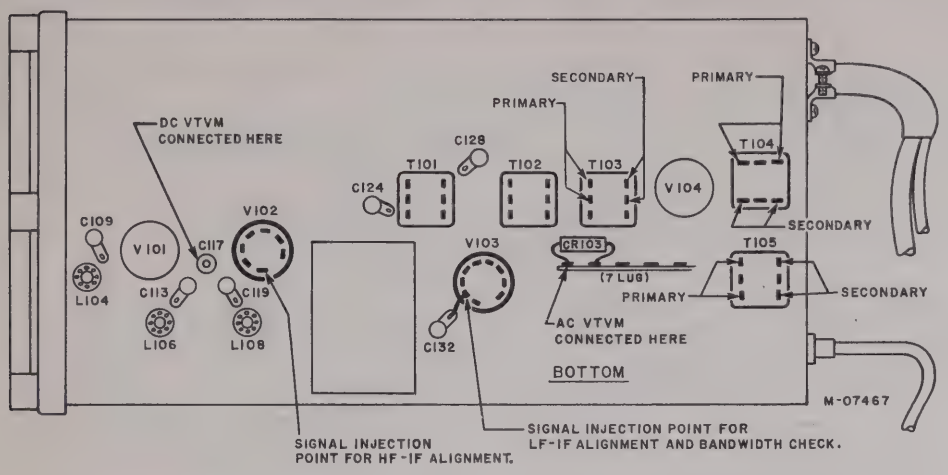


Figure 4-3 COM RECEIVER TEST CONNECTIONS LF IF ALIGNMENT and BANDWIDTH CHECK.

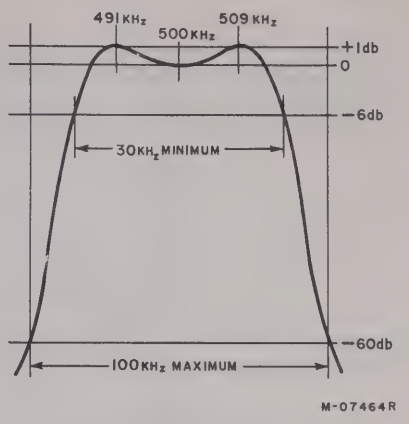


Figure 4-4 COM LF IF PASSBAND.

4.6 COM RECEIVER.

4.6.1 Low Frequency IF Amplifier.

a. Connect an AC VTVM to the anode (unbanded end) of CR-103.

b. Connect a DC VTVM to C-117.

c. Remove all connections from Pin 2, V-103. Connect a 47 ohm resistor from Pin 2, V-103 to ground.

Connect a signal generator to Pin 2, V-103. Set the signal generator to 500 MHz. Set the signal generator output level to the lowest value which will give a useable negative voltage indication on the DC VTVM (with no signal, the DC VTVM should indicate a positive voltage).

d. Temporarily connect a 33K resistor across the secondary winding of each LF IF transformer, T-103, T-104, and T-105. Keep resistor leads short to avoid regeneration.

e. Adjust the primaries (tuning slugs nearer the chassis) of T-103, T-104, and T-105 for maximum negative voltage indication on the DC VTVM. Reduce the signal generator output as necessary to maintain a minimum useable negative voltage indication.

f. Remove the 33K resistors from the secondary windings, and temporarily attach them to the primary windings of T-103, T-104, and T-105.

g. Adjust the Secondaries (tuning slugs farther from the chassis) of T-103, T-104, and T-105 for maximum negative voltage indication on the DC VTVM. Reduce the signal generator output as necessary to maintain the minimum useable negative voltage indication.

h. Remove the three 33K resistors. Modulate the signal generator 30 % with a 400 Hz signal. Adjust the signal generator output level to produce a reading of 0.4 Volt RMS on the AC VTVM.

Normal Indication: 75 μ v maximum input for 0.4 VAC.

i. Remove all test equipment and replace all connections to Pin 2, V-103.

4.6.2 LF IF Bandwidth.

a. Connect a DC VTVM and signal generator as described in steps b. and c. of paragraph 2.6.1.

b. Adjust the signal generator output level to produce a useable negative voltage indication on the DC VTVM. Vary the signal generator frequency over the IF passband. The negative voltage indication should peak approximately 10 KHz either side of 500 KHz, with 500 KHz falling at the bottom of the dip between peaks. Use the DC VTVM reading at this dip as the reference level for bandwith measurement.

c. Increase the signal generator output 6 db (2:1) above the value used in step b. Tune the signal generator frequency above 500 KHz until the reference level is obtained on the DC VTVM and note the frequency. Tune the generator below 500 KHz until the reference level is again reached and note that frequency. The difference between these two frequencies is the total of 6 db bandwith.

d. Increase the signal generator output level 60 db (1000:1) above the value used in step b. Tune the signal generator frequency above and below 500 KHz until the reference level is reached, as in step c. The difference between these two frequencies is the total 60 db bandwidth.

Normal Indication: 6 db - 30 KHz minimum total bandwidth.
60 db - 100 KHz maximum total bandwidth.
(Figure 4-4)

e. Remove all test equipment and replace all connections to Pin 2, V-103.

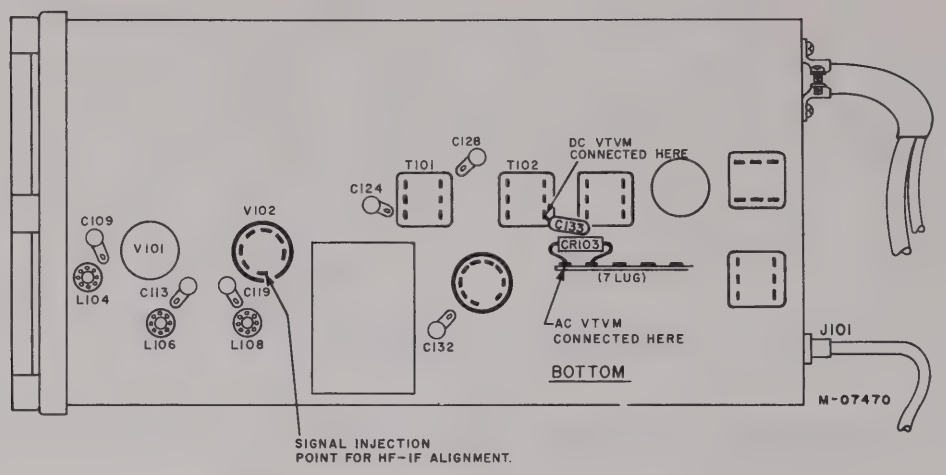


Figure 4-5 COM RECEIVER TEST CONNECTIONS HF IF and RF ALIGNMENT.

4.6.3 HF IF Amplifier.

a. Connect an AC VTVM to the anode (unbanded) end of CR103. Connect a DC VTVM to C-117.

b. Remove all connections from Pin 1, V-102. Connect a 47 ohm resistor from Pin 1, V-102, to ground. Connect a signal generator to Pin 1, V-102.

c. Set the fractional megahertz selector to the .00 position. Set the signal generator to 9.475 MHz. Increase the signal generator output to the lowest level which will provide a useable negative voltage indication on the DC VTVM. Adjust T-102 and the primary and secondary slugs of T-101 for maximum negative voltage indication on the DC VTVM. Reduce the signal generator level as necessary to maintain minimum useable negative DC Voltage indication. Several peaks may be observed as the slug of T-102 is adjusted. Use the peak position in which the slug is farthest from the chassis.

d. Set the fractional megahertz selector to the .90 position. Set the signal generator to 8.575 MHz. Adjust C-132, C-128, and C-124 for maximum negative DC voltage.

e. Repeat steps c. and d. until no further increase in negative DC voltage is obtained.

f. Modulate the signal generator 30% by 400 Hz and check each fractional megahertz position for AC voltage on the AC VTVM. See Table 4.2 for the HF intermediate frequency at each fractional MHz setting.

Normal Indication: 30 v maximum for 0.4 VAC.

g. Remove the signal generator and 47 ohm resistor from Pin 1, V-102, and replace all connections.

4.6.4 RF Amplifier.

a. Connect an AC VTVM to the anode (unbanded) end of CR-103. Connect a DC VTVM to C-117.

b. Connect a VHF signal generator to J-101, the COM antenna connector.

CAUTION: DO NOT KEY THE TRANSMITTER! TRANSMITTER POWER MAY DAMAGE THE SIGNAL GENERATOR.

c. Set the channel selectors and the signal generator to 118.50 MHz. Increase the signal generator output to the lowest level which will produce a useable negative voltage indication on the DC VTVM. Adjust C-109, C-113, and C-119 for maximum negative DC voltage.

d. Set the channel selectors and the signal generator to 135.50 MHz. Adjust L-104, L-106, and L-108 for maximum negative DC voltage.

e. Repeat steps c. and d. until no further increase in negative DC voltage is obtained.

f. Modulate the signal generator 30% by 1000 Hz. Set the channel selectors and signal generator to 118.50 MHz. Increase the signal generator level until the AC VTVM reads 0.4 VAC. Repeat this check with the channel selectors and the signal generator set at 135.50 MHz.

Normal Indication: 5 μ v maximum input for 0.4 VAC.

g. Remove all test equipment.

4.6.5 Sensitivity and Audio Output.

a. Connect an audio wattmeter to the speaker output.

b. Connect VHF signal generator to J-101. Modulate the signal generator 30% by 1000 Hz.

CAUTION: DO NOT KEY THE TRANSMITTER! TRANSMITTER POWER MAY DAMAGE THE SIGNAL GENERATOR.

c. Set the channel selectors and signal generator to 118.00 MHz. Set the COM volume control to the middle of its range. Set the NAV volume control fully counterclockwise and pull the knob. Adjust the signal generator output level to produce a 6db (4: 1) difference in audio power readings with and without modulation.

d. Set the COM volume control fully clockwise and adjust the signal generator level (modulated) to produce 3 watts of audio power.

e. Repeat steps c. and d. with the channel selectors and signal generator set at 126.50 and 135.95 MHz.

Normal Indication: 2 μ v maximum for 6db signal plus noise to noise at the speaker output.
5 μ v maximum for 3 watts at the speaker output.

TABLE 4.2COM Receive HF IF Frequencies

COM High Frequency Channel	Intermediate Frequencys.
.00	9.475
.05	9.425
.10	9.375
.15	9.325
.20	9.275
.25	9.225
.30	9.175
.35	9.125
.40	9.075
.45	9.025
.50	8.975
.55	8.925
.60	8.875
.65	8.825
.70	8.775
.75	8.725
.80	8.675
.85	8.625
.90	8.575
.95	8.525

4.6.6 Squelch Compensation.

a. Connect the VHF signal generator to J-101, the COM antenna connector. Adjust the signal generator. Adjust the signal generator and the Mark-12B to the same frequency.

b. Turn the squelch knob fully counterclockwise (maximum squelch).

c. Increase the signal generator level from zero until audio is heard to break through.

Normal Indication: Input levels of 10 to 25 microvolts should break maximum squelch.

d. If signal level required to break maximum squelch is less than 10 microvolts, shunt R-131 as necessary to increase the level to more than 10 microvolts. If the squelch breaking level is greater than 25 microvolts, replace R-131 with a higher value resistance to reduce the level to less than 25 microvolts.

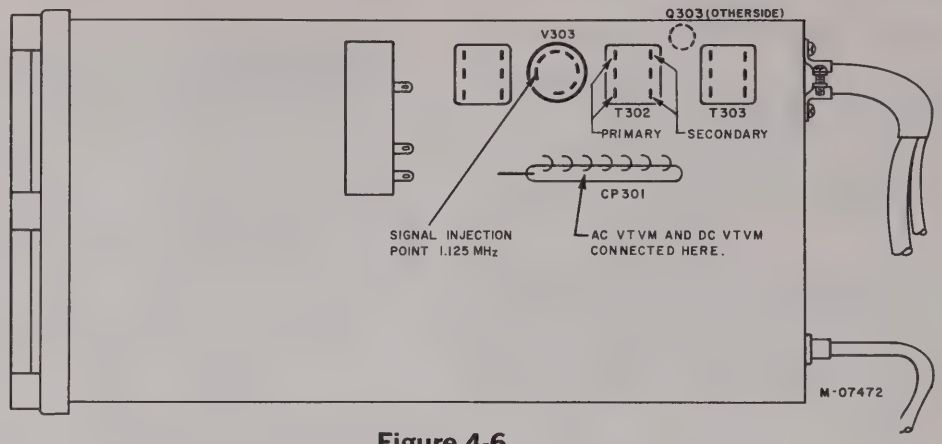


Figure 4-6
NAV LF IF ALIGNMENT CONNECTIONS.

4.7 NAVIGATION RECEIVER ALIGNMENT.

4.7.1 Low Frequency IF Amplifier.

a. Connect an AC VTVM and a DC VTVM to lead 5 of CP-301.

b. Connect an RF VTVM to the collector of Q-303.

c. Remove all connections from Pin 1, V-303. Connect a 47 ohm resistor from Pin 1 to ground, and connect a signal generator to Pin 1. Set the signal generator to 1.125 MHz.

d. Temporarily connect two 33K resistors across the primary and secondary windings of T-302. Keep leads short to avoid coupling.

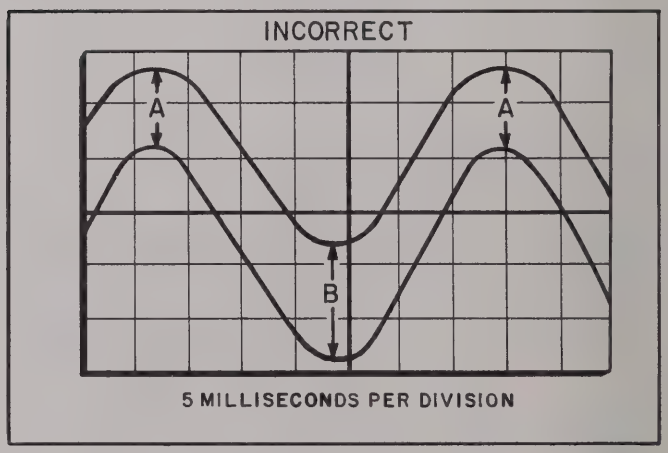
e. Increase the signal generator output to the lowest level which gives a usable negative DC voltage indication on the DC VTVM. Adjust both slugs of T-302 for maximum negative voltage indication, making certain each slug is in the peak position farthest from the center of the transformer. Adjust the primary (slug nearer the chassis) of T-303 for maximum negative DC voltage. Adjust the secondary (slug farther from the chassis) for *minimum* RF voltage on the RF VTVM. Repeat the adjustments of T-303 until maximum negative DC and minimum RF indications are obtained. Both slugs of T-303 must be in the peak positions farthest from the center of the transformer. The correct primary peak is very slight.

f. Remove the two 33K resistors from T-302. Modulate the signal generator 30% by 400 Hz. Increase the signal generator output level until a reading of 1.9 volts is obtained on the AC VTVM.

Normal Indication: 350 μ v maximum input for 1.9 VAC

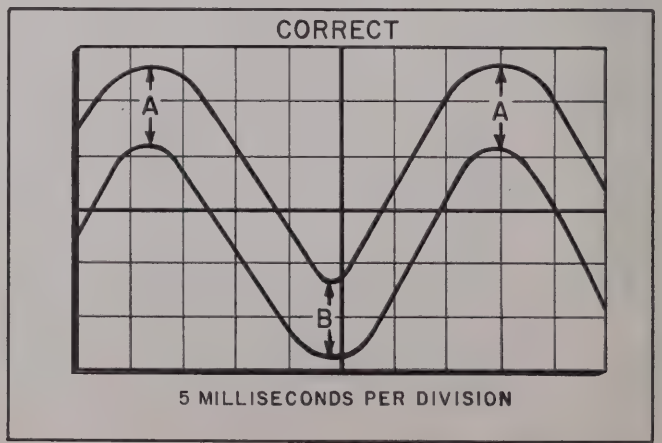
g. Remove all test equipment and replace all connections to Pin 1, V-303.

h. Optional oscilloscope waveform alignment (OMNI snake) for better OMNI accuracy.
   1. Connect scope to pin 5 of CP-301.
   2. Connect TIC T12A NAVCOM Generator, or equalivant, to NAV antenna input.
   3. Tune to VOR channel and observe waveform.



B-07500R

4. If waveform does not have uniform thickness between A and B, slightly adjust TOP slug of T-303 until A and B are equal in thickness.



B-07500L

4.7.2 LF IF Bandwidth.

a. Connect a DC VTVM and signal generator as described in steps a. and b. under 4.7.1.

b. Adjust the signal generator output to the minimum level which produces a useable negative voltage indication on the DC VTVM. Vary the signal generator frequency across the LF IF passband. The negative voltage indication should peak approximately 10 KHz either side of the 1.125 MHz center frequency, with 1.125 MHz falling at the bottom of a slight dip. The DC VTVM reading at this dip is the reference for LF IF bandwidth measurements.

c. Increase the signal generator output level 6 db (2: 1) above the level used in step b. Tune the signal generator above 1.125 MHz until the DC VTVM again shows the reference level, and note the frequency. Tune the signal generator below 1.125 MHz until the reference level is again reached and note the frequency. The difference between these two frequencies is the total 6 db bandwidth.

d. Increase the signal generator output level 60 db (1000: 1) above the level used in step b. Tune the signal generator above and below 1.125 MHz until the reference level is reached, as in step c. The difference between these two frequencies is the total 60 db bandwidth.

Normal Indication: 6 db - 38KHz minimum total bandwidth.
60 db - 340 KHz maximum total bandwidth.
(Figure 4-7)

e. Remove all test equipment and replace all connections to Pin 1, V-303.

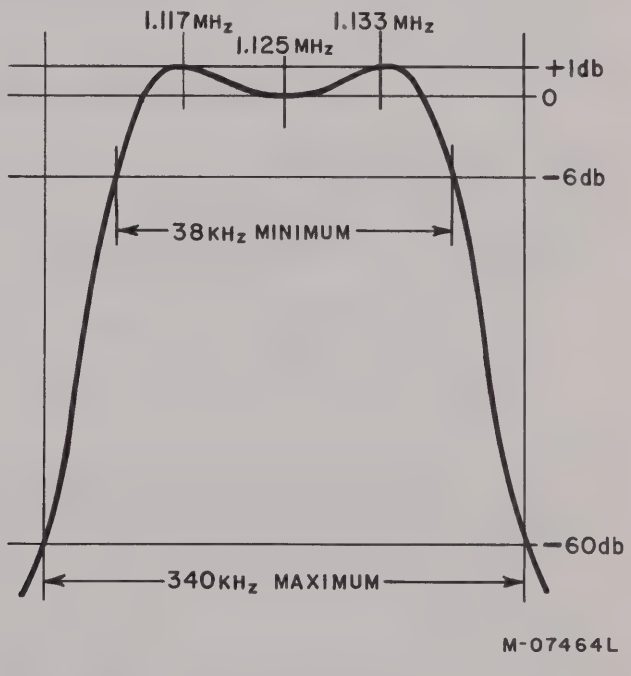


Figure 4-7 NAV LF IF PASSBAND.

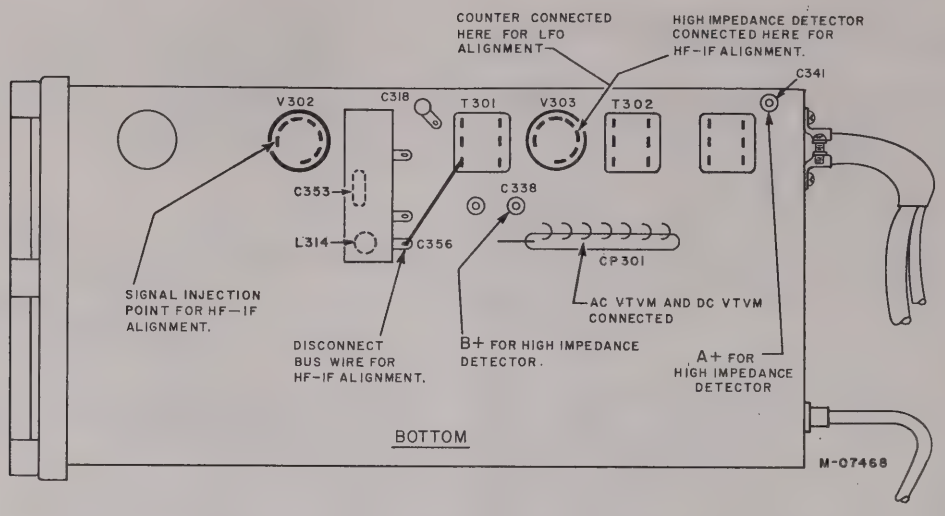


Figure 4-8 NAV HF IF and LFO ALIGNMENT CONNECTIONS.

4.7.3 HF IF Amplifier.

a. Disconnect Pin 5, V-303, from T-302. Connect a high impedance detector (See Figure 4-8) as follows:
   Connect the B + lead to C-338.
   Connect the plate lead to Pin 5, V-303.
   Connect the A + lead to C-341.
   Connect the AC VTVM to the high impedance detector output.

b. Remove all connections from Pin 1, V-302. Connect a 47 ohm resistor from Pin 1, to ground, and connect a signal generator to Pin 1. Modulate the signal generator 30% by 400 Hz.

c. Disconnect the buss wire from C-356, then ground the buss wire.

d. Set the fractional megahertz selector to the .9 position. Set the signal generator to 12.35 MHz and adjust its output level for a useable indication on the AC VTVM. Adjust both slugs of T-301 for maximum indication on the AC VTVM.

e. Set the fractional megahertz selector to the .0 position. Set the signal generator to 11.45 MHz. Adjust C-318 for maximum indication on the AC VTVM.

f. Repeat steps d. and e. until no further increase in AC VTVM indication is obtained.

g. Check the signal generator frequency at which the maximum indication on the AC VTVM is obtained on each fractional megahertz selector position. This frequency should be no more than ± 15 KHz from the center frequency given in Table 4.3.

h. Disconnect all test equipment and replace all connections to V-302, V-303, and C-356.

4.7.4 Low Frequency Oscillator.

PRIMARY METHOD

Procedure:

a. Determine that the HF IF is properly aligned.

b. Disconnect Pin 5, V-303 from T-302. Connect a 39 μ hy choke from Pin 6, V-303 to Pin 5, V-303. Connect a 47 pf 500V capacitor from Pin 5, V-303 to the input of the frequency counter. Remove all connections from Pin 1, V-302.

c. Set L-314 to midrange. (Tuning screw half way in). Set C-353 to midrange. (Slot for tuning tool parallel to the chassis).

d. Set the fractional MHz selector to the .9 position. Observe the frequency indicated on the counter. Adjust L-314 for an indication of 11.225 MHz on the counter.

e. Set the fractional MHz selector to the .0 position. Observe the frequency indicated on the counter. Adjust C-353 for an indication of 10.325 MHz on the counter.

f. Repeat steps d. and e. until the circuit is tracked. Check the frequency of each fractional MHz position. The frequency must be within ± 8 KHz of the center frequency of each position. See Table 4.4.

g. Reconnect the components previously removed from Pin 1, V-302. Remove the counter, 47 pf capacitor, and 39 μ hy choke from Pin 5 and Pin 6 of V-103. Reconnect Pin 5, V-303 to T-302.

ALTERNATE METHOD

Procedure:

a. Calibrate a BC-221 or equivalent frequency meter to the nearest crystal check point related to the 10 MHz through 11 MHz range.

b. Connect a length of insulated wire (#22 hook up wire is adequate) to the antenna post of the BC-221. Insert the other end of the wire into the plate and screen area of V-303. Take care that the wire is well away from the control grid area of V-303 or oscillator frequency pulling will be experienced.

c. Set the fractional MHz selector to the .9 position. Set the BC-221 to 11.225 MHz. Adjust L-314 for a zero beat from the BC-221.

d. Set the fractional MHz selector to the .0 position. Set the BC-221 to 10.325 MHz Adjust C-353 for a zero beat from the BC-221.

e. Repeat steps c. and d. until the circuit is tracked. Check the frequency of each fractional MHz position. The frequency must be within ±8 KHz of the center frequency for each position.

Normal Indication:

Each fractional MHz position must be no more than 8 KHz from its center frequency.

4.7.5 Overall IF Gain.

a. Connect an AC VTVM to lead 5 of CP-301.

b. Remove all connections from Pin 1, V-302. Connect a 47 ohm resistor from Pin 1 to ground and connect a signal generator to Pin 1. Modulate the signal generator 30% by 1000 Hz.

c. Set the fractional MHz selector to each of the following positions, and the signal generator to the corresponding frequency. Note the input required to produce 1.9 VAC on the AC VTVM at each frequency.

Fractional MHz Selector	Signal Generator Frequency
.0	11.45 MHz
.5	11.95 MHz
.9	12.35 MHz

Normal Indication: 20 μ v maximum input for 1.9 VAC detector output.

d. Remove all test equipment and replace all connections to Pin 1, V-302.

TABLE 4.3
NAV Received HF IF Frequencies

NAV High Frequency Channel	Intermediate Frequency Center Frequency (MHz)
.0	11.45
.1	11.55
.2	11.65
.3	11.75
.4	11.85
.5	11.95
.6	12.05
.7	12.15
.8	12.25
.9	12.35

TABLE 4.4
NAV LFO Frequencies

Channel	Frequency (MHz)
.0	10.325
.1	10.425
.2	10.525
.3	10.625
.4	10.725
.5	10.825
.6	10.925
.7	11.025
.8	11.125
.9	11.225

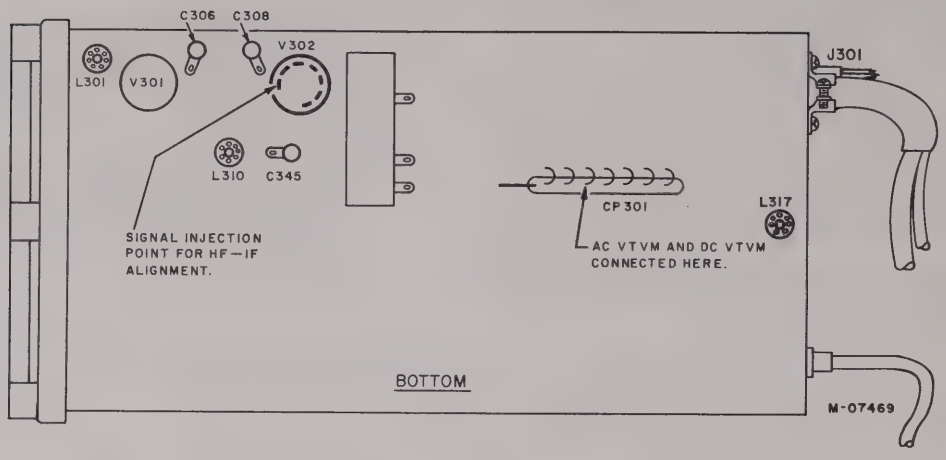


Figure 4-9
NAV HFO and RF ALIGNMENT CONNECTIONS.

4.7.6 High Frequency Oscillator.

a. Connect a RF VTVM probe to Pin 1, V-302.

b. Set the megahertz selector to the 108 position. Adjust C-345 for maximum RF voltage indication.

c. Set the megahertz selector to the 117 position. Adjust L-310 for maximum RF voltage indication.

d. Repeat steps b. and c. until no further increase in RF voltage indication is obtained.

e. Check to insure that the oscillator is operating in each megahertz position. Operation is indicated by a normal RF indication.

Normal Indication: 0.5 V RMS Nominal.
0.3 V RMS Minimum.

4.7.7 RF Amplifier.

a. Connect an AC VTVM and DC VTVM to lead 5 of CP-301.

b. Connect a VHF signal generator to J-301.

c. Set the channel selectors and signal generator to 108.5 MHz. Increase the signal generator output to provide a useable negative voltage indication on the DC VTVM. Adjust C-306 and C-308 for maximum negative DC voltage.

d. Set the channel selectors and signal generator to 117.5 MHz. Adjust L-301 for maximum negative DC voltage.

e. Repeat steps c. and d. until no further increase in negative DC voltage is obtained.

f. Modulate the signal generator 30% by 1000 Hz. Check the input level required to produce 1.9 VAC on the AC VTVM at 108.0, 112.5, and 117.9 MHz.

Normal Indication: 2.5 μ v maximum input for 1.9 VAC.

4.7.8 Sensitivity and Audio Output.

a. Connect an audio wattmeter to the speaker output.

b. Connect the signal generator to J-301. Modulate the signal generator 30% by 1000 Hz.

c. Set the NAV volume control to the middle of its range, and pull the knob. Set the COM volume control fully counterclockwise. Set the channel selector and signal generator to 108.0 MHz. Adjust the signal generator output level so the audio wattmeter reading with modulation is 6 db (4:1) greater than the reading without modulation.

d. Repeat step c. with channel selector and signal generator set at 112.5 MHz and 117.9 MHz.

Normal Indication: 2 μ v maximum input for 6 db signal plus noise to noise at speaker output.

e. Turn the NAV volume control fully clockwise. Adjust the signal generator output level to provide 4.5 watts audio output with the channel selectors and signal generator set at 108.0, 112.5, and 117.9 MHz.

Normal Indication: 3 μ v maximum input for 4.5 watts at speaker output.

4.7.9 Ident Filter Alignment.

a. Connect an audio wattmeter to the speaker output.

b. Connect a VHF signal generator to J-301. Modulate the signal generator 30% by 1020 Hz.

c. Set the channel selectors and signal generator to 117.5 MHz. Set the signal generator output level to 500 μ v. Pull the NAV volume control knob and adjust it for 3 watts on the audio wattmeter. Push the NAV volume control knob in and adjust L-317 for a minimum indication on the audio wattmeter.

Normal Indication: Audio level should be 50 mw maximum at speaker output with NAV volume control knob pushed in.

4.8 MODULATOR-POWER UNIT.

The only control requiring adjustment is the microphone gain control. It is adjusted at the factory for normal carbon microphones, and should need adjustment only if the MK-12B is to be used with a microphone providing a higher output level. If adjustment is required, proceed as follows:

4.8.1 Recommended Method (Bench Adjustment).

Connect the Unit to a primary power source. Connect the microphone to the Modulator-Power and accessory cable. Connect an oscilloscope to C-205 (feed-thru capacitor in left front corner of chassis).

Connect a 50 ohm, 10 watt, dummy load to the COM antenna jack. If possible, have the pilot speak into the microphone in his normal manner. Turn the gain control fully counterclockwise. Key transmitter and, while speaking into the microphone, adjust the gain control until the positive and negative voice peaks, viewed on the oscilloscope, begin flattening.

4.8.2 Alternate Method (Adjustment in Aircraft).

Connect the microphone to the Mark 12B. Connect the common lead to a Simpson Model 260 VOM, or equivalent, to the Mark 12B chassis. Connect the probe to C-205, (feed-thru capacitor in left front corner of the chassis). Set the VOM function selector to "output." Key the transmitter, and while speaking a sustained "ah" into the microphone, adjust the gain control for a reading of 60 to 75 volts on the VOM.

4.9 CONVERSION, 90 to 360 COMMUNICATION CHANNELS.

Caution: The Mark-12B conversion kit, NARCO No. EL-307/-503, must be used for this conversion.

The proper Mark-12B COM HFO crystals bear correlation letters QQ. Mark-12B COM LFO crystals bear correlation letters RR.

4.9.1 Fractional Megahertz Crystals.

a. Installation.

This kit contains ten crystals which are to be installed in the low frequency oscillator crystal assembly. The LFO crystal assembly is located just to the rear of V-103 and V-204. It will be noted that this assembly contains crystals in every other crystal position only on both the top and bottom sides of the chassis.

Viewed from the top, front, install the highest frequency crystal of this kit (9.425 MHz) in the vacant crystal space on the extreme left - *nearest chassis edge.* NOTE: Descending crystal oscillator operating frequency is ascending channel selector frequency; i.e., 9.475 MHz = .00, 8.252 MHz = .95. Install the remaining crystals, in descending frequency order, in the vacant crystal spaces working from left to right. When the top row is completed, five crystals should have been used.

Turn the chassis over. Install the remaining five crystals in the open crystal spaces in the bottom row. Viewed from the bottom, front, install the crystals in descending frequency order working from left to right. Use care in soldering crystal leads to prevent heat damage to the crystal. Do not bend crystal leads at a right angle at the point where they emerge from the crystal case. This could fracture the glass seal.

b. Detent Arrangment.

The fractional MHz detent is located at the rear of the chassis on the top side to the left of T-105 between T-101 and T-102. It will be noted that this assembly has a star wheel on each end. On the one end, toward the front of the unit, is a ten position star wheel; on the other end, toward the rear of the unit, a twenty position star wheel. This detent must be reversed, or turned around, so that the twenty position star wheel is toward the front of the unit (See Figure 4-10) for 360 channel operation.

Before removing the detent, set the fractional MHz selector to a position where the rotor tabs of the crystal assembly or of the HF IF step inductors can be observed. Note, at the same time, the frequency indicated by the fractional MHz dial. This is necessary so that proper indexing can be reestablished easily.

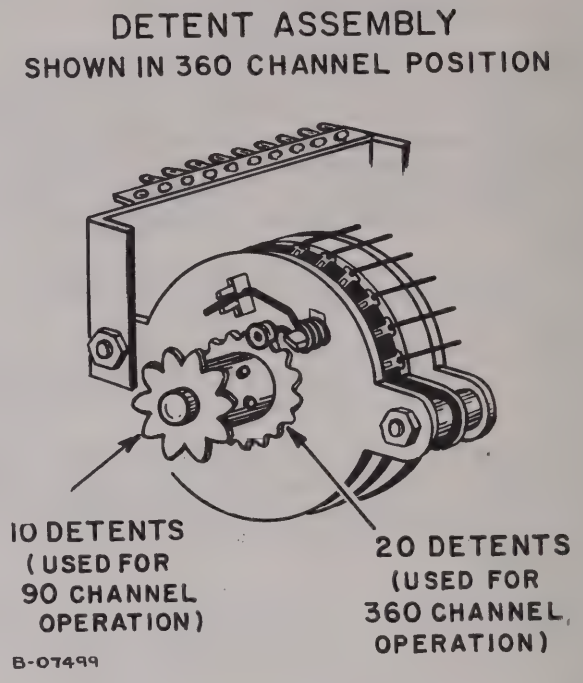


Figure 4-10 DETENT CONVERSION

Remove the detent spring and the detent roller. Then loosen the two setscrews in the dual star wheel assembly and slide the assembly to the rear of the Unit and off the shaft. In the event there is insufficient space to completely remove the star wheel assembly from the shaft, it will be necessary to remove the "COM" fractional MHz Knob and loosen the setscrews securing the fractional MHz dial to its shaft. The fractional MHz shaft can then be moved forward enough to remove the star wheel assembly. Turn the star wheel assembly around so that the twenty position star wheel is toward the front of the unit, then slide it back on its shaft. Now replace the detent roller and detent spring. Note that the long end of the detent spring shall be retained in position, by placing this end on the inside of the outermost tab on the detent mounting plate. Check the rotor tabs at the chosen reference point for indexing, then secure the setscrews in the star wheel assembly. Provide about .005 inch end play between the star wheel assembly and the bushing in the detent mounting plate. If the fractional MHz Knob and dial have been loosened, resecure them in their proper position as noted above.

After the final check of the assembly, a small amount of wide temperature range grease should be applied to the spring fulcrum, roller, and star wheel detent teeth.

4.9.2 Whole Megahertz Crystals.

a. Installation.

This kit contains nine crystals which are to be installed in the high frequency oscillator crystal assembly. Viewed from the top, front, the HFO assembly is located on the left side approximately midway between the front and rear of the chassis. It is enclosed in a box. Remove the top and the bottom covers. Each is held in place by two machine screws.

Viewed from the front, top side, it will be noted that the HFO crystal assembly has three empty crystal spaces to the left of its top center, and six empty crystal spaces to the right of its top center. Install these nine crystals in these spaces, in ascending frequency order working from left to right. Use care in soldering crystal leads to prevent heat damage to the crystal. It may be necessary to remove C-251 and L-218 to install crystals in the last two spaces.

b. Stop Removal.

The top on the MHz selector detent plate at the 126 position must now be broken out. To gain access to this stop, the knobs, mask, and trim panel must be removed. Before disassembly of the front panel, it is well to set the selectors to a reference frequency position for reassembly. Removal of the front panel assembly will reveal the detent plate. The stop will be locate on the rear side at the bottom and center of the detent plate. The stop is merely a lance, approximately 1/16 of an inch wide, in the detent plate itself. Break this stop out, and the MHz selector will channel to the 135 position. Exercise care that the channel selectors indicate the proper channel when the front panel is reassembled.

4.9.3 Post Conversion Check-out.

After the crystals are installed, the detents properly adjusted, and the HFO covers reassembled, give the radio an operational performance check. Alignment of the HFO, the transmitter, and the receiver RF section should be checked. In the event realignment is necessary, refer to the appropriate part of the alignment procedure section of this manual. A new frequency check slip is required for the transmitter which reflects the original plus the new channels that have been activated.

HFO frequency may be checked by inserting a long, slim one turn pickup loop through one of the trimmer access holes in the oscillator side of the HFO box. LFO frequency may be checked by holding a pickup loop near T-201. LFO frequency should be checked in transmit mode.

4.10 SELECTED COMPONENTS.

The values of capacitors C-331 and C-355 in the Mark-12B are selected for proper circuit operation as follows:

C-331 is selected to adjust the coupling between windings of T-302, to control the bandwidth of the NAV receiver. Increasing C-331 narrows the receiver bandwidth. This capacitor should range from 0 to 1.5 pf. See paragraph 4.7.2 for bandwidth measurement techniques.

C-355 is selected to permit proper tracking of the NAV low-frequency oscillator. In aligning this oscillator, C-353 may be found to have sufficient range for tracking. The value of C-355 may then be increased or decreased to permit tracking. See paragraph 4.7.4 for NAV LFO alignment procedure.

For proper squelch operation, a resistor (R-345) may be shunted across R-131. See paragraph 4.6.6, for squelch compensation procedure.

TABLE 4.5

Channel Selector Ground Circuits, DME (S-309, S-310B).

CHANNEL SELECTOR GROUND CIRCUITS.

Frequency (MHz)	CONNECTOR PIN No. (P-202)									
	Fractional MHz(S-310B)					Whole MHz.(S-309)				
	F	H	J	K	L	D	A	E	C	B
108. 108.1	 X	X X			X			X X		X X
108.2 108.3	X	 X	X X					X X		X X
108.4 108.5		X	 X	X X				X X		X X
108.6 108.7			X	 X	X X			X X		X X
108.8 108.9	X X			X	 X			X X		X X
109. 110.		X X			X X		X X		 X	X
111. 112.		X X			X X	 X			X	X X
113. 114.		X X			X X	X		 X	X X	
115. 116.		X X			X X	X X	 X	X		
117. 118.		X X			X X		X	X X		

NOTES

1. Fractional Megahertz sequence (S-301B, 0.1 to 0.9 MHz) repeated for each MHz from 108 to 118 MHz.
2. X signifies that the circuit is at ground potential.

TABLE 4.6
Channel Selector Ground Circuits, OMNI/LOC and Glide Slope
(S-310A, S-305A & B, S-312A & B)

NAV Channel (MHz)	Glide Slope Channel (MHz)	CONNECTOR NO.												
		P-301	P-201											
		4	B	E	A	D	H	L	P	R	N	K	F	C
108.0 108.1	— 334.7	X	X	X X	X									
108.2 108.3	— 334.1	X	X	X X		X								
108.4 108.5	— 329.9	X	X	X X			X							
108.6 108.7	— 330.5	X	X	X X				X						
108.8 108.9	— 329.3	X	X	X X					X					
109.0 109.1	— 331.4	X	X							X				
109.2 109.3	— 332.0	X	X								X			
109.4 109.5	— 332.6	X	X									X		
109.6 109.7	— 333.2	X	X										X	
109.8 109.9	— 333.8	X	X											X
110.0 110.1	— 334.4	X	X		X									
110.2 110.3	— 335.0	X	X			X								
110.4 110.5	— 329.6	X	X				X							
110.6 110.7	— 330.2	X	X					X						
110.8 110.9	— 330.8	X	X						X					
111.0 111.1	— 331.7	X	X	X X						X				
111.2 111.3	— 332.3	X	X	X X							X			
111.4 111.5	— 332.9	X	X	X X								X		
111.6 111.7	— 333.5	X	X	X X									X	
111.8 111.9	— 331.1	X	X	X X										X
112. 113. 114.	— — —			X* X* X*	SEE NOTE BELOW									
115. 116.	— —													
117. 118.	— —													

NOTES

1. X signifies that the circuit is at ground potential.
2. Since P-301/4 and P-201/B (Columns 3 & 4) control the OMNI/LOC and G/S circuits, they are not grounded when the channel selectors are set above 111.9 MHz There is grounding of the remaining pins of P-201 as the channel changes are made; however they can be disregarded since the activate leads are not grounded above 111.9 MHz.

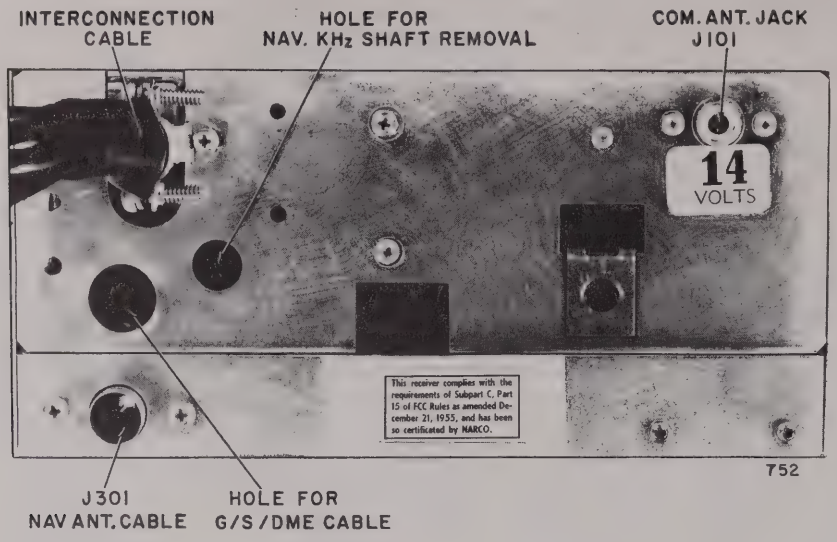

INTERCONNECTION CABLE
HOLE FOR NAV. KHz SHAFT REMOVAL
COM. ANT. JACK J101
14 VOLTS
This receiver complies with the requirements of Subpart C, Part 15 of FCC Rules as amended December 21, 1955, and has been so certificated by NARCO.
752
J301 NAV ANT. CABLE
HOLE FOR G/S / DME CABLE

Figure 4-11 PANEL UNIT, REAR VIEW

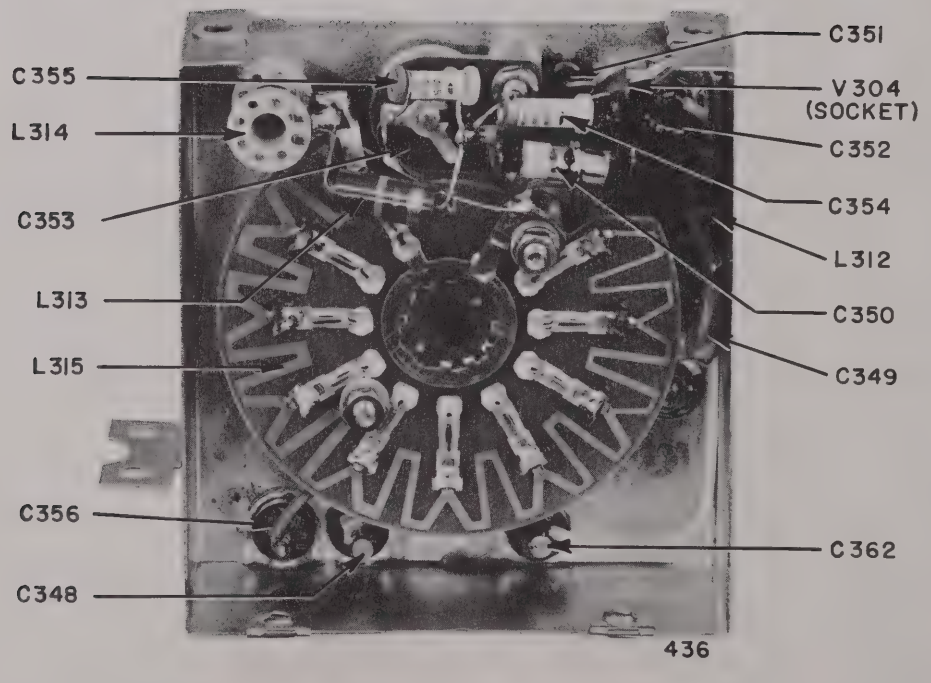


Figure 4-12 NAV LFO SUBASSEMBLY, FRONT VIEW

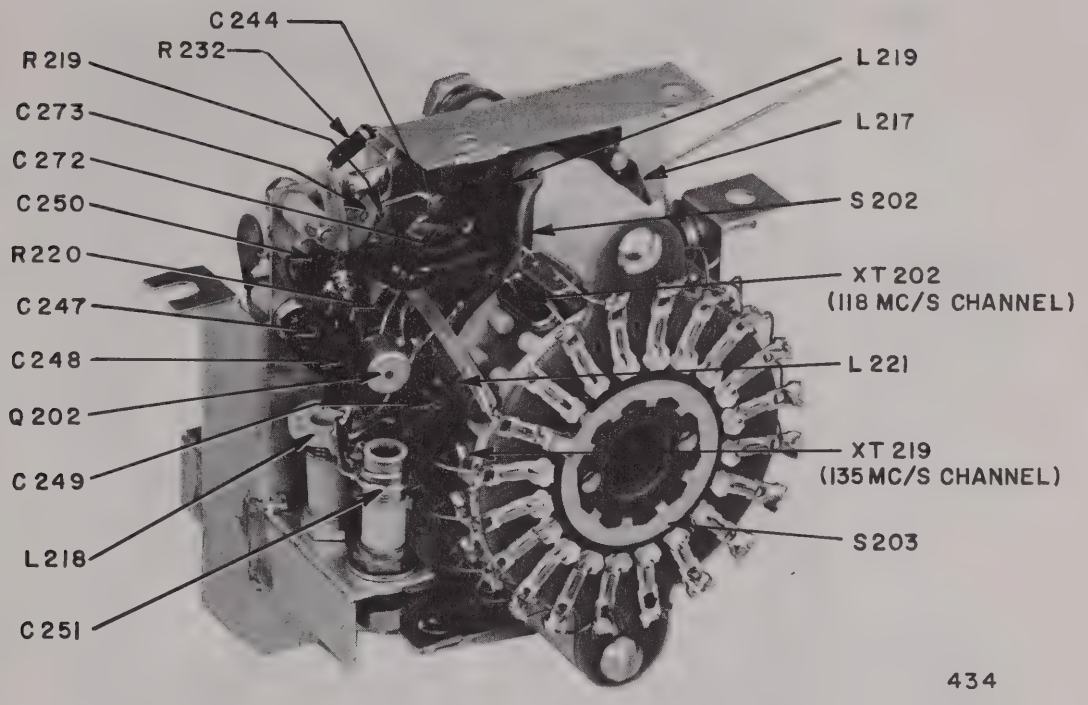


Figure 4-13 COM HFO SUBASSEMBLY, FRONT VIEW

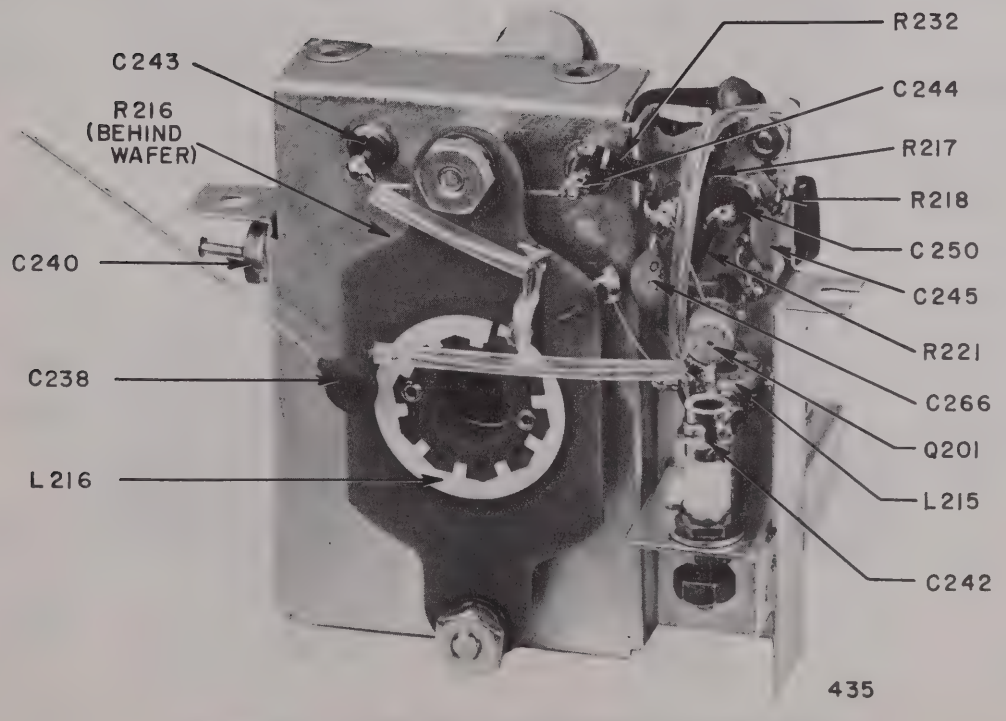


Figure 4-14 COM HFO SUBASSEMBLY, REAR VIEW

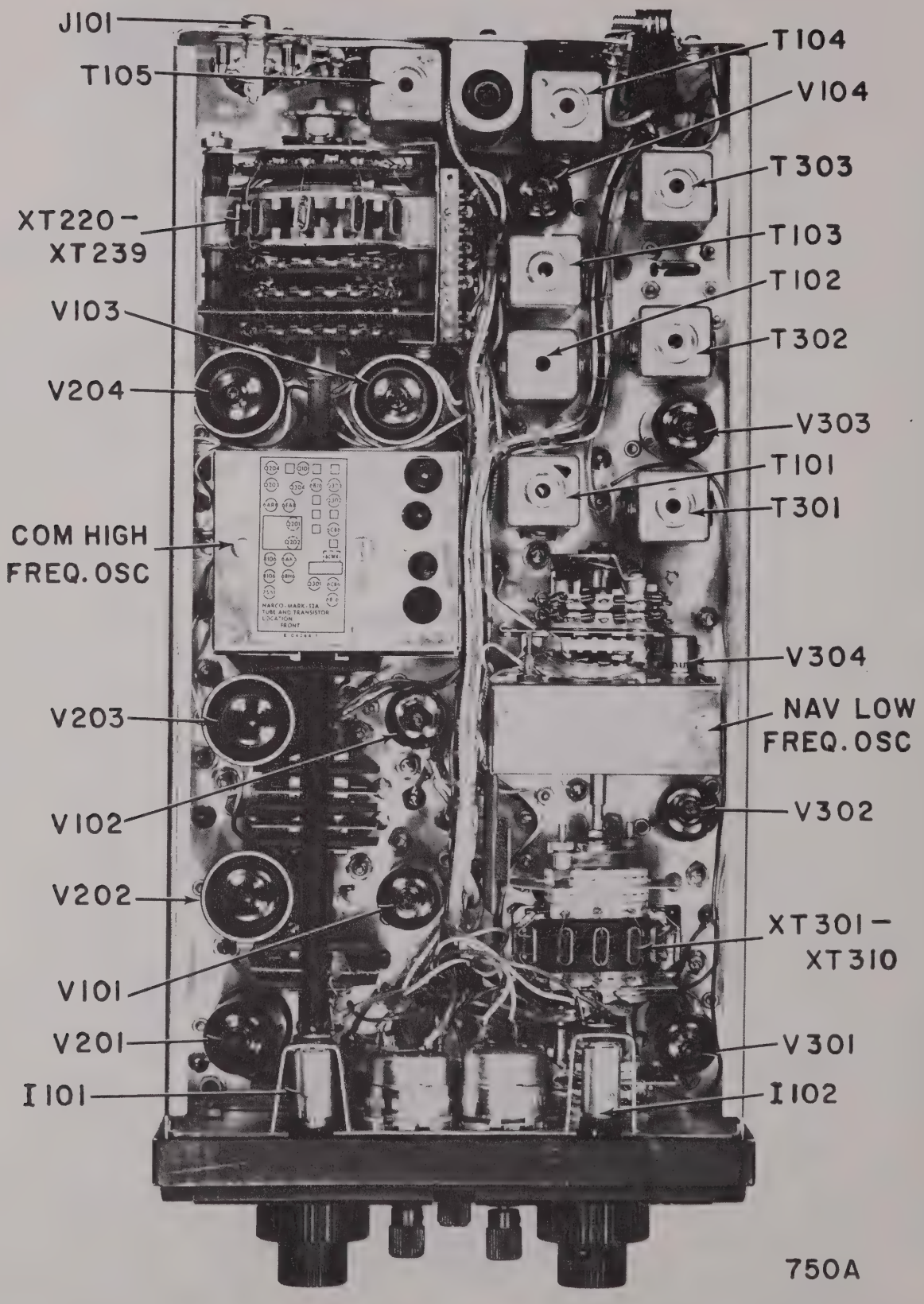


Figure 4-15 PANEL UNIT, TOP VIEW (Sheet 1 of 2)

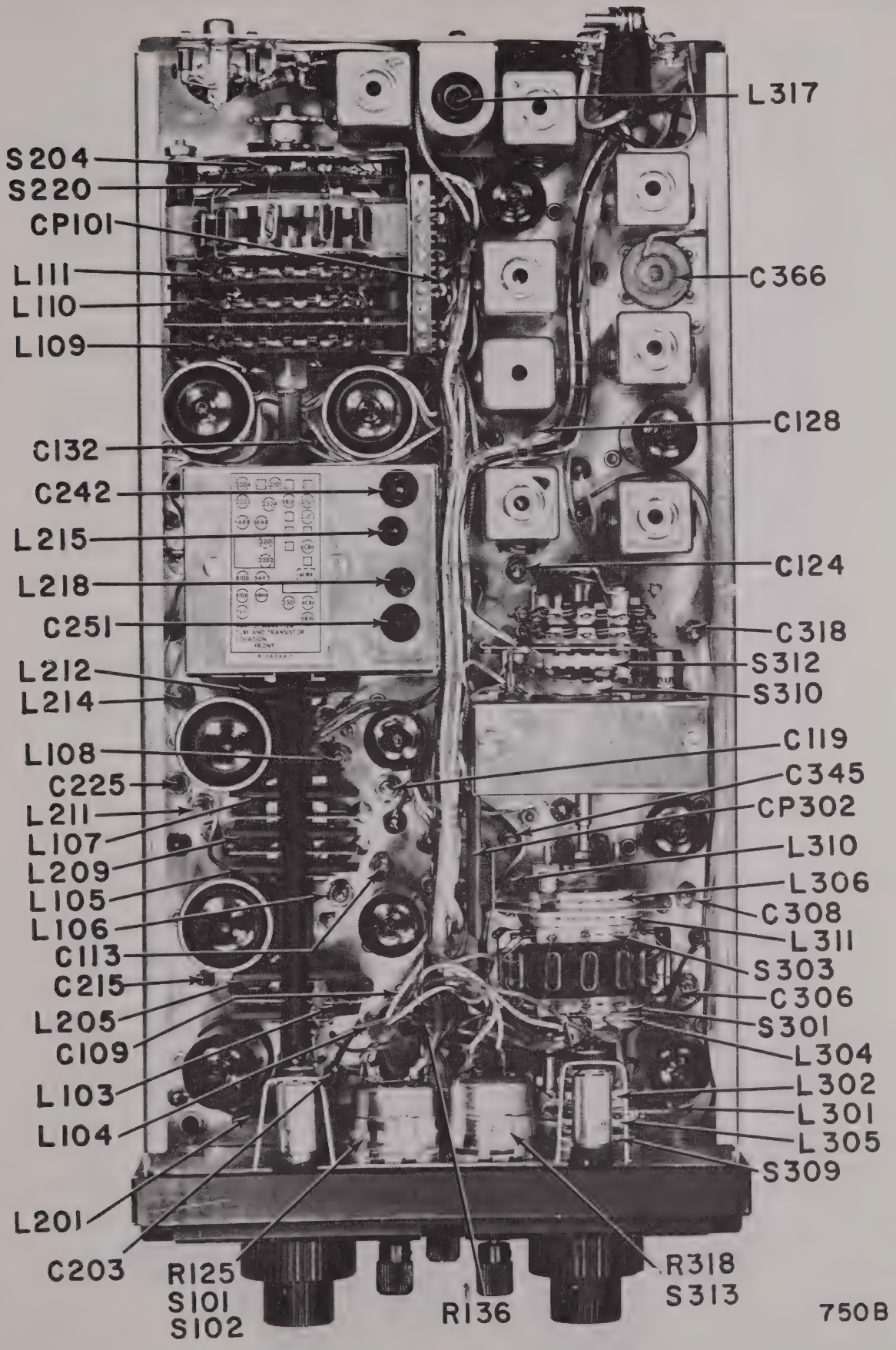


Figure 4-15 PANEL UNIT, TOP VIEW (Sheet 2 of 2)

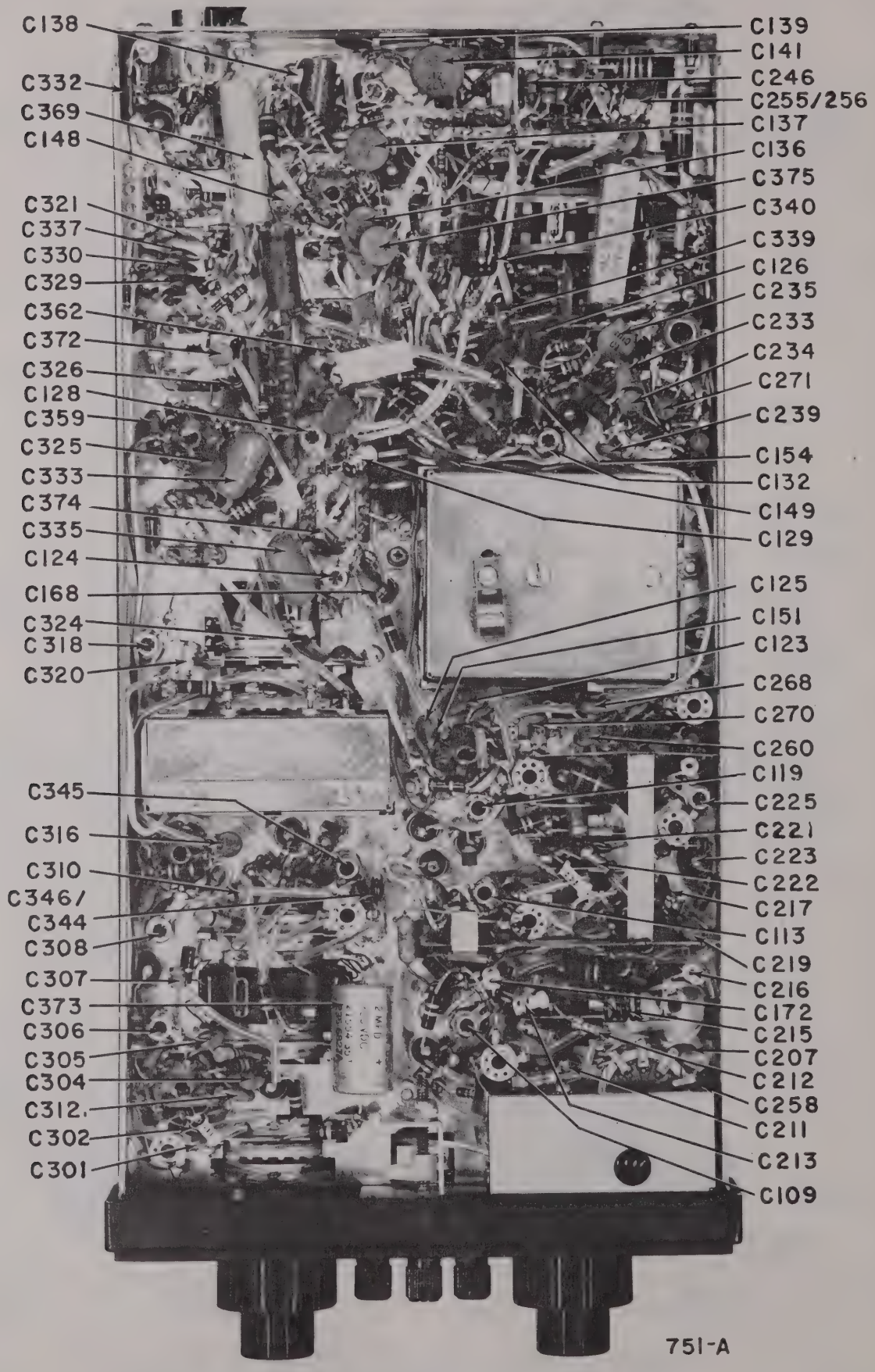


Figure 4-16 PANEL UNIT, BOTTOM VIEW (Sheet 1 of 3)

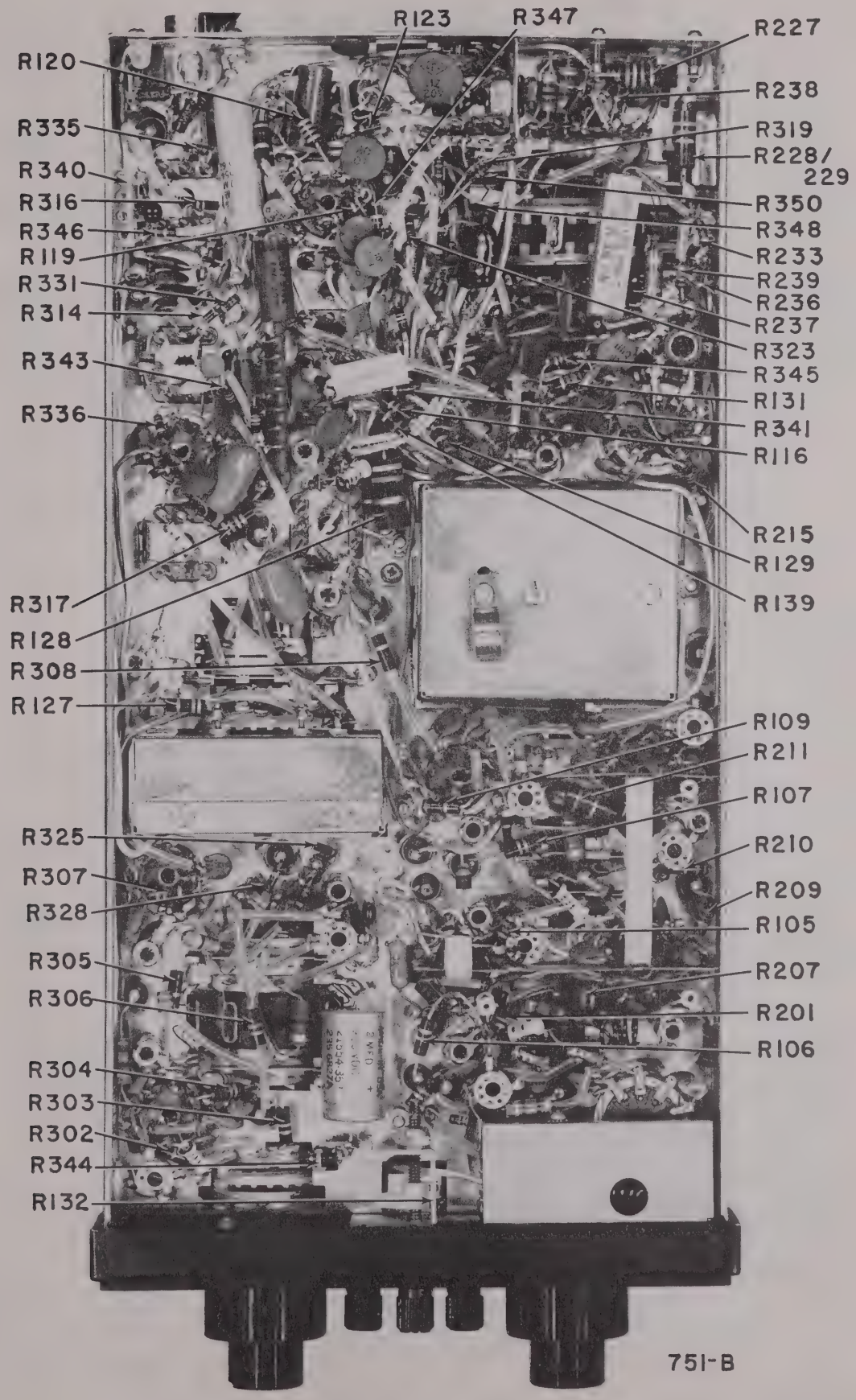


Figure 4-16 PANEL UNIT, BOTTOM VIEW (Sheet 2 of 3)

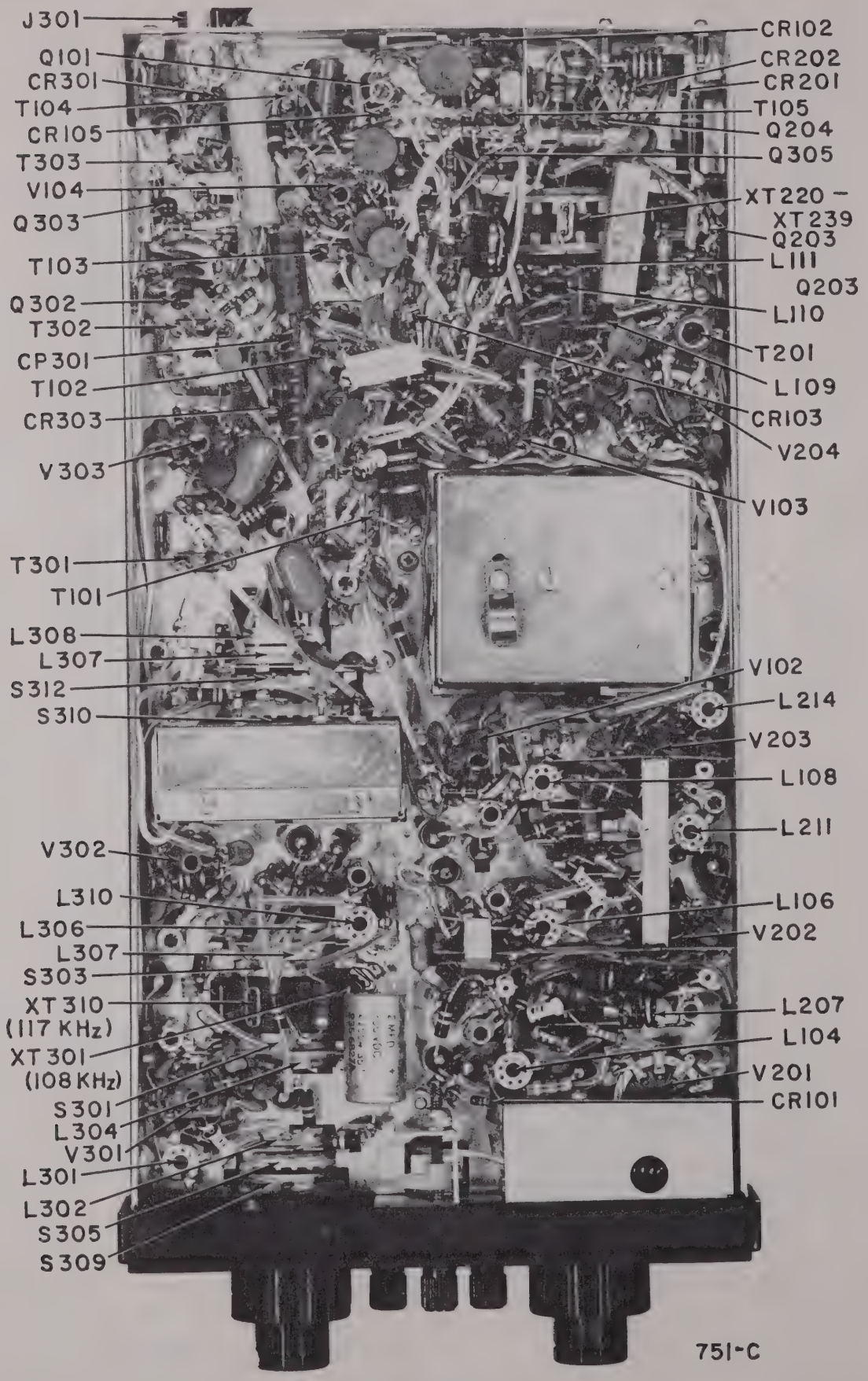
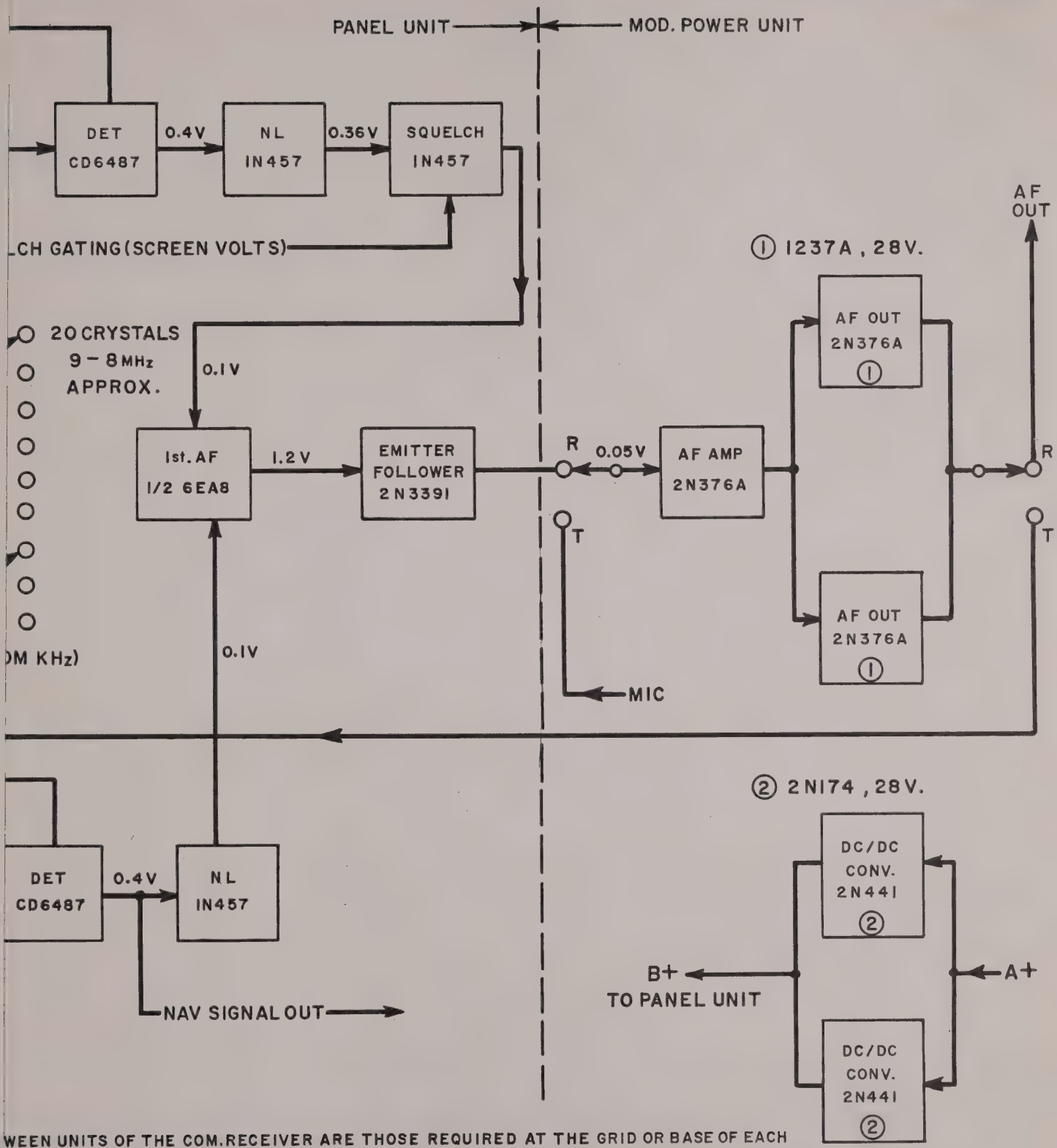


Figure 4-16 PANEL UNIT, BOTTOM VIEW (Sheet 3 of 3)



WEEN UNITS OF THE COM. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH
-6 VOLTS AGC AT HOT SIDE OF C133.

WEEN UNITS OF THE NAV. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH
-15 VOLTS AGC AT LEAD 5 OF CP301.

ARE APPROXIMATE VALUES, PROVIDED FOR RAPID CHECKS. SIGNAL LEVELS DEPEND ON THE
TAGES AND ON THE INTERNAL IMPEDANCE OF THE SIGNAL GENERATOR USED.

WEEN UNITS OF THE AUDIO PORTIONS OF BOTH RECEIVERS AND THE COMMON AUDIO AMPLIFIERS
D AT THE GRID OR BASE OF EACH STAGE TO PRODUCE 4.5 WATTS AUDIO OUTPUT AT 400 Hz

T-07197

Figure 4-17 MARK 12B BLOCK DIAGRAM

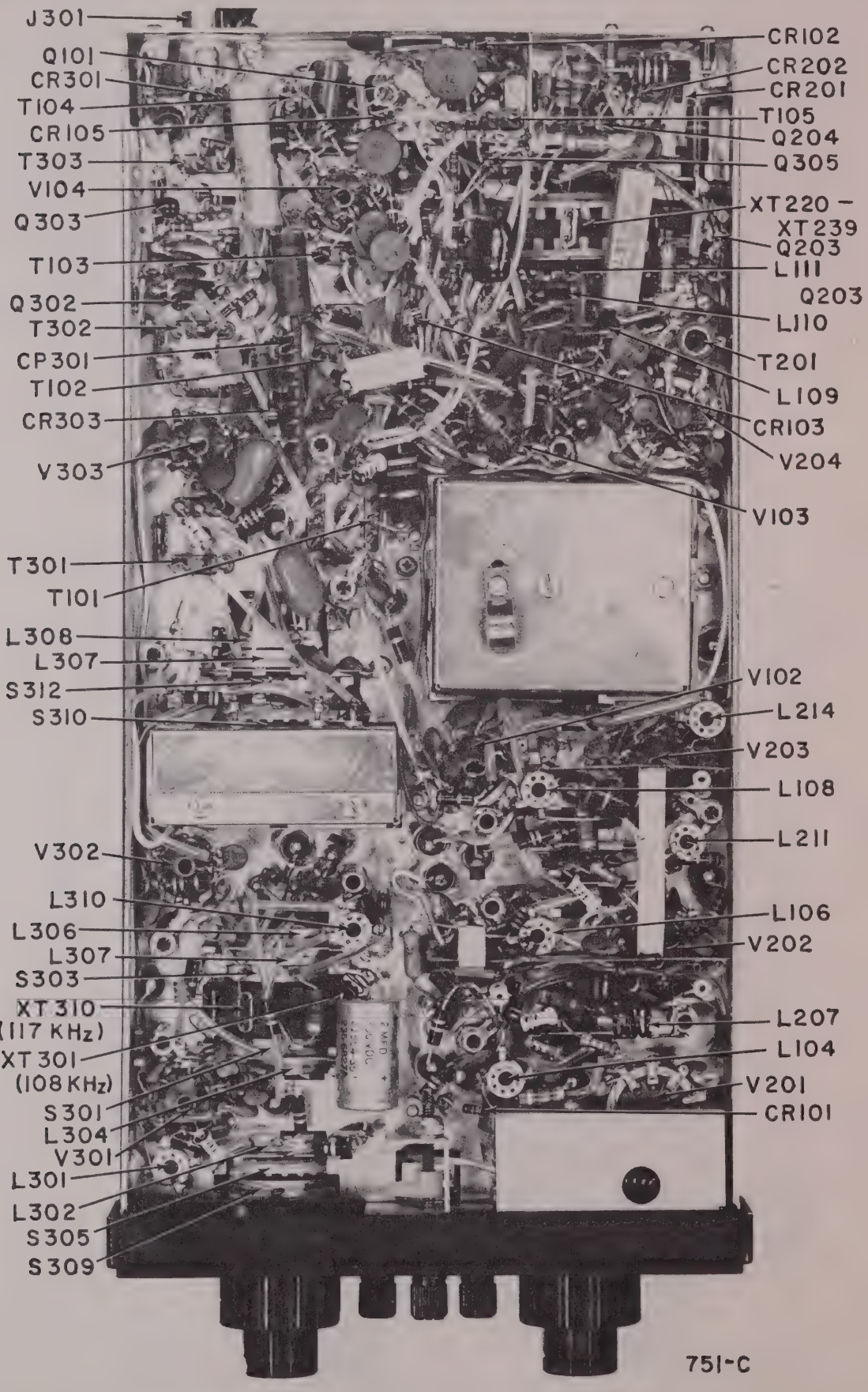
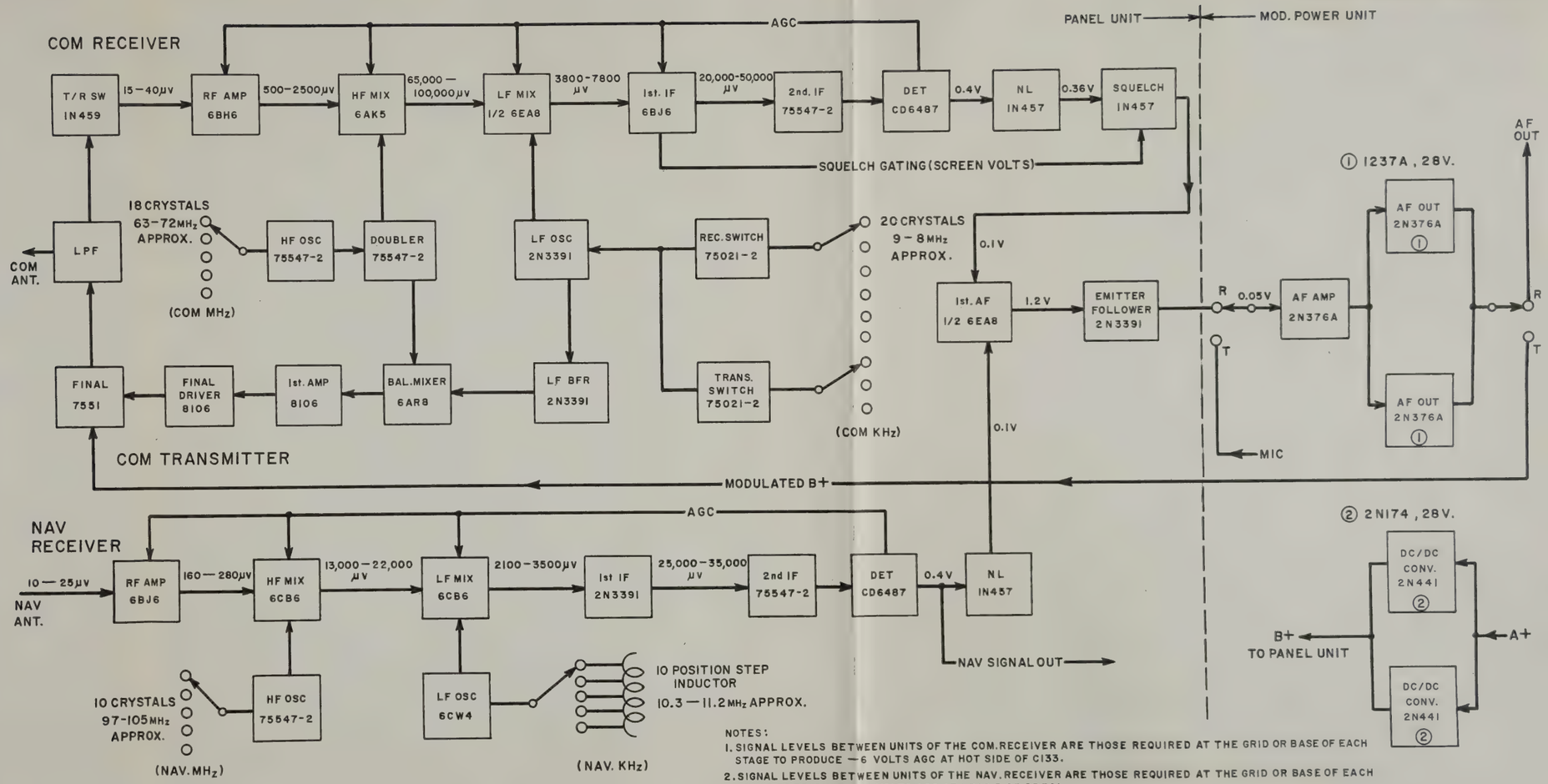


Figure 4-16 PANEL UNIT, BOTTOM VIEW (Sheet 3 of 3)



NOTES:

1. SIGNAL LEVELS BETWEEN UNITS OF THE COM. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH STAGE TO PRODUCE –6 VOLTS AGC AT HOT SIDE OF C133.
2. SIGNAL LEVELS BETWEEN UNITS OF THE NAV. RECEIVER ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH STAGE TO PRODUCE –15 VOLTS AGC AT LEAD 5 OF CP301.
3. THE ABOVE SIGNALS ARE APPROXIMATE VALUES, PROVIDED FOR RAPID CHECKS. SIGNAL LEVELS DEPEND ON THE GAIN OF INDIVIDUAL STAGES AND ON THE INTERNAL IMPEDANCE OF THE SIGNAL GENERATOR USED.
4. SIGNAL LEVELS BETWEEN UNITS OF THE AUDIO PORTIONS OF BOTH RECEIVERS AND THE COMMON AUDIO AMPLIFIERS ARE THOSE REQUIRED AT THE GRID OR BASE OF EACH STAGE TO PRODUCE 4.5 WATTS AUDIO OUTPUT AT 400 Hz

T-07197

Figure 4-17 MARK 12B BLOCK DIAGRAM

5.1 INTRODUCTION

This Replacement Parts List supports the Mark 12B NAV/COM. For ease of part identification and location the list is divided into two sections, one for the Panel Unit, and one for the Modulator-Power Units. Standard commerical parts are listed with a NARCO part number and a complete description. Special parts, applicable only to the unit or system, are listed with a NARCO part number and a basic description, these parts must be ordered from NARCO.
When ordering replacement parts, specify the NARCO part number and the parts description.

MARK 12B PANEL UNIT, Mechanical Parts

Symbol or Item No.	Part No.	Description
	72025-101	KIT, CRYSTAL, MK-12A/B MHz COMM.
	72025-102	KIT, CRYSTAL, MK-12A/B MHz COMM.
	72025-103	KIT, CRYSTAL, MK-12A/B MHz COMM.
	72025-104	KIT, CRYSTAL, MK-12A/B KHz COMM.
	72025-105	KIT, CRYSTAL, MK-12A/B KHz COMM.
	72025-106	KIT, CRYSTAL, MK-12A/B MHz NAV.
	04119-1	LABEL, 14V
	04119-2	LABEL 28V
	04342-1	LABEL, LOGO
	04356-1	LABEL, TUBE LOCATION
	04002-3	LABEL, LICENSE NOTICE
	04011-1	LABEL, CAUTIONS TRANS.
	04069-1	LABEL, FCC, CERT.
	56410-1	COVER, BOTTOM. OSC, NAV.
	56466-101	CHASSIS, OSC., COMM.
	56477-1	COVER, TOP, OSC., COMM.
	56426-1	COVER, BOTTOM, OSC., COMM
	56427-101	CHASSIS, NAV. OSC. ASSY
	56414-102	CASE ASSY.
	56499-101	CHASSIS ASSY
	56409-1	COVER, TOP OSC. NAV
	56500-1	PANEL, TRIM
	56405-1	RETAINER, SWITCH
	56406-1	SHIELD, NAV
	56406-2	SHIELD, NAV
	56478-1	SHIELD, NAV
	56407-1	SHIELD, COMM
	56481-1	SHIELD, RF
	56469-1	SHIELD, BUFFER
	56473-1	SHIELD, AMPLIFIER
	56432-1	SHIELD, HF IF COMM
	56433-1	SHIELD, HF IF NAV
	56470-1	SHIELD, DRIVER
	56416-6	SHAFT, NAV KHz
	56430-3	SHAFT, COMM KHz
	56431-1	SHAFT, COMM KHz
	56429-3	SHAFT, COMM MHz
	56454-1	BRACKET, SUPPORT XTAL, GRD.
	56471-1	BRACKET, SUPPORT INDICATOR, TOP
	56472-1	BRACKET, SUPPORT INDICATOR, BOTTOM
	56486-1	BRACKET, GROUNDING
	56479-1	BRACKET, P.E.C.
	56485-1	CLIP, GROUNDING
	56458-1	CLIP, CONTACT
	56459-1	BRIDGE, GRD. BENT
	56460-1	BRIDGE, GRD. FLAT
	56480-1	STRAP, GROUNDING
	56474-1	COVER, AMP.
	56494-1	BUSHING, INSULATOR

MARK 12B PANEL UNIT, Mechanical Parts Continued

Symbol or Item No.	Part No.	Description
	56569–1	BRACKET, LATCH
	61405–101	DETENT, PLATE, COMM Hz
	61402–1	DETENT, SPRING
	61401–1	DETENT, ROLLER
	61404–101	DETENT ASSY., ROLLER
	61463–3	DETENT ASSY., COMM MHz
	61481–2	DETENT & SHAFT ASSY., NAV MHz
	61382–1	DETENT, PLATE, NAV KHz
	61377–1	DETENT, ADJ., NAV KHz
	61484–1	STATOR, INSULATOR
	56482–1	SPRING, GROUNDING
	81656–11	BUTTON, PLUG
	51686–3	LENS, CHANNEL SELECTOR, COMM.
	51686–5	LENS, CHANNEL SELECTOR, NAV
	52768–1	LATCH
	54514–3	SPRING, GROUND
	54451–1	XTAL HOLDER, COMM MHz
	55520–1	XTAL HOLDER, NAV MHz
	55740–2	BEARING PLATE
	41147–3	SOCKET, PILOT LIGHT
	41225–2	SOCKET, PILOT LIGHT
	42061–1	SOCKET, NUVISTOR
	42051–3	TUBE SHIELD, TELESCOPING
	42034–3	TUBE SOCKET, 9 PIN
	42033–5	TUBE SOCKET, 7 PIN
	42034–6	TUBE SOCKET, 9 PIN
	42060–4	TUBE SOCKET, 9 PIN REC.
	81433–3	TIE LUG STRIP
	81407–3	TIE LUG STRIP SUB–MINIATURE
	81408–1	TIE LUG STRIP, SUB–MINIATURE
	81409–1	TIE LUG STRIP, SUB–MINIATURE
	81410–1	TIE LUG STRIP SUB–MINIATURE
	81410–3	TIE LUG STRIP, SUB–MINIATURE
	81407–1	TIE LUG STRIP, SUB–MINIATURE
	81407–2	TIE LUG STRIP, SUB–MINIATURE
	81460–1	TIE LUG STRIP, SUB–MINIATURE
	81459–1	TIE LUG STRIP, SUB–MINIATURE
	81738–1	LUG, SOLDER
	81335–6	INSULATOR, SHOULDER
	82011–1	CLAMP, CABLE
	84069–1	RECEPTACLE
	84071–1	HAIR PIN RETAINER
	84071–2	COTTER, HAIR PIN
	04380–1	INSERT, KNOB, VOL.
	88178–1	KNOB, MHz COMM & NAV
	88181–2	KNOB, KHz NAV
	88181–1	KNOB, KHz COMM
	88189–1	KNOB, SQUELCH & VOL.
	88180–1	HUB, MHz COMM
	88180–2	HUB, MHz NAV

MARK 12B PANEL UNIT, Mechanical Parts Continued

Symbol or Item No.	Part No.	Description
	88179-3	DIAL, MHz COMM
	88179-5	DIAL, MHz NAV
	88182-3	DIAL, KHz COMM
	88182-5	DIAL, KHz NAV
	90621-103	CABLE ASSY.

MARK 12B PANEL UNIT, Electrical Parts

Symbol or Item No.	Part No.	Description
C-101	21299-470	CAPACITOR, CERAMIC TUB., 47pf ± 10%, 500V, NPO
C-102	21201-270	CAPACITOR, CERAMIC TUB., 27pf ± 10%, 500V, NPO
C-103	21201-270	CAPACITOR, CERAMIC TUB., 27pf ± 10%, 500V, NPO
C-104	21291-21	CAPACITOR, CERAMIC DISC., 1000pf ± 20%, 1 KV
C-105	21291-21	CAPACITOR, CERAMIC DISC., 1000pf ± 20%, 1KV
C-106	21298-1	CAPACITOR, FEED THRU, 1000pf + 100% -0%, 500V
C-107	21384-750	CAPACITOR, CERAMIC DISC., 75pf ±5%, N-750, 500V
C-108	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-109	22019-1	CAPACITOR, VARIABLE PLUNGER, 0.5-4.5pf
C-110	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-111	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C-112	24516-229	CAPACITOR, CERAMIC DISC, 2.2pf ± .25pf, 500V
C-113	22019-1	CAPACITOR, VARIABLE PLUNGER, 0.5 - 4.5pf, 500V
C-114	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-115	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C-116	21298-1	CAPACITOR, FEED THRU, 1000pf + 100% -0%, 500V
C-117	21298-1	CAPACITOR, FEED THRU, 1000pf + 100% -0%, 500V
C-118	24509-228	CAPACITOR, CERAMIC, 0.22pf ± 5%, 500V
C-119	22019-1	CAPACITOR, VARIABLE PLUNGER, 0.5 - 4.5pf, 500V
C-120	24502-688	CAPACITOR, CERAMIC, 0.68pf ± 20%, 500V
C-121	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-122	24516-150	CAPACITOR, CERAMIC DISC, 15pf ±10%, 500V
C-123	21291-4	CAPACITOR, CERAMIC DISC, .003uf + 80% -20%, 500V
C-124	22019-1	CAPACITOR, VARIABLE PLUNGER, .5 - 4.5pf, 500V
C-125	24516-689	CAPACITOR, CERAMIC DISC, 6.8pf ± 0.5pf, 500V
C-126	21291-6	CAPACITOR, CERAMIC DISC, .01uf, 500V, GMV
C-127	24516-339	CAPACITOR, CERAMIC DISC, 3.3pf ± 0.25pf, 500V
C-128	22019-1	CAPACITOR, VARIABLE PLUNGER, .5 - 4.5pf, 500V
C-129	21201-220	CAPACITOR, CERAMIC TUB., 22pf ± 10%, 500V, NPO
C-130	21291-9	CAPACITOR, CERAMIC DISC, .003mf ± 10%, 500V
C-131	24516-829	CAPACITOR, CERAMIC DISC, 8.2pf ± 0.5pf 500V, NPO
C-132	22019-1	CAPACITOR, VARIABLE PLUNGER, .5 - 4.5pf, 500V
C-133	21291-5	CAPACITOR, CERAMIC DISC, .01mf +80% -20%, 50V
C-134	23085-171	CAPACITOR, MYLAR, .047uf ±10%, 200V
C-135	21291-5	CAPACITOR, CERAMIC DISC, .01mf + 80% -20%, 50V
C-136	24515-7	CAPACITOR, CERAMIC DISC, .05 uf + 80% -20%, 20V
C-137	21291-6	CAPACITOR, CERAMIC DISC, .01uf + 80% -20%, 500V
C-138	23085-171	CAPACITOR, MYLAR, .047uf ± 10%, 200V
C-139	24515-1	CAPACITOR, CERAMIC DISC, 0.1mf +80% -20%, 10V
C-140	24515-1	CAPACITOR, CERAMIC DISC. 0.1mf + 80% -20%, 10V
C-141	24515-6	CAPACITOR, CERAMIC DISC, 0.1mf + 80% -20%, 20V
C-142	24515-7	CAPACITOR, CERAMIC DISC, .05uf +80% -20%, 20V
C-143	21291-21	CAPACITOR, CERAMIC DISC, 1000 pf ±20%, 1KV
C-144	24049-221	CAPACITOR, DIPPED MICA, 220pf ± 5%, 500V
C-145	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Descriptikn
C–146	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–147	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–148	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–149	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–150	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–151	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–152	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–153	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1 KV
C–154	24515–1	CAPACITOR, CERAMIC DISC, 0.1uf +80% –20%, 10V
C–155	21291–5	CAPACITOR, CERAMIC DISC, .01mf +80% –20%, 50V
C–156	24515–7	CAPACITOR, CERAMIC DISC, .05mf +80% –20%, 20V
C–157	21291–6	CAPACITOR, CERAMIC DISC, .01mf 500V, GMV
C–158	21298–1	CAPACITOR, FEEDTHRU, 1000pf + 100% –0%, 500V
C–159	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–160	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–161	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0% 500V
C–162	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–163	21291–6	CAPACITOR, CERAMIC DISC, .01mf, 500V, GMV
C–164	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–165	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–166	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–167	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–168	24516–829	CAPACITOR, CERAMIC DISC, 8.2pf ± 0.5pf, 500V
C–169	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C–170	24049–101	CAPACITOR, DIPPED MICA, 100pf ±5%, 500V
C–171	24049–330	CAPACITOR, DIPPED MICA, 33pf ± 5%, 500V
C–172	21201–339	CAPACITOR, CERAMIC TUB, 3.3pf ± .25pf, 500V NPO
C–173	21201–229	CAPACITOR, CERAMIC TUB., 2.2pf ±.25pf, 500V NPO
C–201	21384–750	CAPACITOR, CERAMIC TUB., 75pf ±5%, N–750, 500V
C–202	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C–203	22019–1	CAPACITOR, VARIABLE PLUNGER, .5 – 4.5pf, 500V
C–204	24516–339	CAPACITOR, CERAMIC DISC, 3.3pf ±.25pf, 500V
C–205	21298–1	CAPACITOR, FEED THRU, 1000pf +100% –0%, 500V
C–206	21298–1	CAPACITOR, FEED THRU, 1000pf + 100% –0%, 500V
C–207	21291–25	CAPACITOR, CERAMIC DISC, 430pf ± 10%, 500V
C–208	21291–25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V
C–209	21291–25	CAPACITOR CERAMIC DISC, 430pf ±10%, 500V
C–210	21291–25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V
C–211	21298–1	CAPACITOR, FEED THRU, 1000pf + 100% –0%, 500V
C–212	21384–750	CAPACITOR, CERAMIC TUB., 75pf ± 5%, 500V, N–470
C–213	21201–180	CAPACITOR, CERAMIC TUB., 18pf ±10%, 500V, NPO
C–214	21298–1	CAPACITOR, FEEDTHRU, 1000pf +100% –0%, 500V
C–215	22019–1	CAPACITOR, VARIABLE PLUNGER, .5 – 4.5pf, 500V
C–216	21201–120	CAPACITOR, CERAMIC TUB, 12pf ±10%, 500V, NPO
C–217	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C–218	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C–219	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C–220	21291–21	CAPACITOR, CERAMIC DISC, 1000 pf ±20%, 1KV

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
C-221	21384-750	CAPACITOR, CERAMIC TUB., 75pf ±5%, 500V, N-470
C-222	21201-270	CAPACITOR, CERAMIC TUB., 27pf ±10%, 500V, NPO
C-223	21298-1	CAPACITOR, FEED THRU, 1000pf ±100% -0%, 500V
C-224	21298-1	CAPACITOR, FEED THRU, 1000pf ±100% -0%, 500V
C-225	22019-1	CAPACITOR, VARIABLE PLUNGER, .5 - 4.5pf, 500V
C-226	21201-120	CAPACITOR, CERAMIC TUB., 12pf ± 10%, 500V, NPO
C-227	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-228	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-229	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-230	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-231	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-232	22045-1	CAPACITOR, VARIABLE CERAMIC, 1.5 - 8.0pf, 500V, NPO
C-233	24516-229	CAPACITOR, CERAMIC DISC, 2.2pf ± .25pf, 500V
C-234	24516-229	CAPACITOR, CERAMIC DISC, 2.2pf ± .25pf, 500V
C-235	21291-6	CAPACITOR, CERAMIC DISC, .01uf, 500V, GMV
C-236	24049-330	CAPACITOR, DIPPED MICA, 33pf ± 5%, 500V
C-237	21298-1	CAPACITOR, FEED THRU, 1000pf +100% -0%, 500V
C-238	24516-339	CAPACITOR, CERAMIC DISC, 3.3pf ±0.25pf, 500V
C-239	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-240	21298-1	CAPACITOR, FEED THRU, 1000pf + 100% -0%, 500V
C-241	21298-1	CAPACITOR, FEED THRU, 1000pf +100% -0%, 500V
C-242	22019-1	CAPACITOR, VARIABLE PLUNGER, .5 - 4.5pf, 500V
C-243	21298-1	CAPACITOR, FEED THRU, 1000pf +100% -0%, 500V
C-244	21298-1	CAPACITOR, FEED THRU, 1000pf +100% -0%, 500V
C-245	21291-25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V
C-246	21291-25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V
C-247	24049-470	CAPACITOR, DIPPED MICA, 47pf ±5%, 500V
C-248	24049-180	CAPACITOR, DIPPED MICA, 18pf ±5%, 500V
C-249	24049-240	CAPACITOR, DIPPED MICA, 24pf ±5%, 500V
C-250	21298-1	CAPACITOR, FEED THRU, 1000pf +100% -0%, 500V
C-251	22019-1	CAPACITOR, VARIABLE PLUNGER, 0.5 - 4.5pf, 500V
C-252	21291-5	CAPACITOR, CERAMIC DISC, .01uf + 80% -20%, 50V
C-253	24049-560	CAPACITOR, DIPPED MICA, 56pf ±5%, 500V
C-254	24049-201	CAPACITOR, CERAMIC DISC, 200pf ±5%, 500V
C-255	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-256	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-257	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-258	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-259	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-260	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-261	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-262	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-263	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-264	21291-5	CAPACITOR, CERAMIC DISC, .01uf +80% -20%, 50V
C-265	24502-688	CAPACITOR, CERAMIC, 0.68pf ±20%, 500V
C-266	21291-25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V
C-267	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-268	24516-689	CAPACITOR, CERAMIC DISC, 6.8pf ±0.5pf, 500V
C-269	21298-1	CAPACITOR, FEED THRU, 1000pf + 100% -0%, 500V
C-270	24516-689	CAPACITOR, CERAMIC DISC, 6.8pf ±0.5pf, 500V

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
C–271	24516–479	CAPACITOR, CERAMIC DISC, 4.7pf ±0.5pf, 500V
C–272	24045–681	CAPACITOR, DIPPED MICA, 680pf ±5%, 500V
C–273	21291–25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V
C–274	21201–150	CAPACITOR, TUB. CERAMIC, 15pf ±10%, 500V, NPO
C–275	24516–229	CAPACITOR, CERAMIC DISC, 2.2pf ±0.25pf, 500V
C–301	21201–100	CAPACITOR, CERAMIC TUB., 10pf ± 1.0pf, NPO, 500V
C–302	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C–303	21201–270	CAPACITOR, CERAMIC TUB., 27pf ±10%, 500V
C–304	21291–21	CAPACITOR, CERAMIC DISC., 1000pf ± 20%, 1 KV
C–305	24516–689	CAPACITOR, CERAMIC DISC, 6.8pf ± 0.5pf, 500V
C–306	22019–1	CAPACITOR, VARIABLE PLUNGER, 0.5 – 4.5pf, 500V
C–307	24509–688	CAPACITOR, CERAMIC, 0.68pf ±5%, 500V
C–308	22019–1	CAPACITOR, VARIABLE PLUNGER, 0.5 – 4.5pf, 500V
C–309	24516–479	CAPACITOR, CERAMIC DISC, 4.7pf ±0.5pf, 500V
C–310	24509–828	CAPACITOR, CERAMIC 0.82pf ±5%, 500V
C–311	21291–25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 1 KV
C–312	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C–313	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C–314	21291–21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C–315	21291–4	CAPACITOR, CERAMIC DISC,.003uf +80% –20%, 500V
C–316	21291–21	CAPACITOR,CERAMIC DISC, 1000pf ± 20%, 1KV
C–317	24516–150	CAPACITOR, CERAMIC DISC, 15pf ±10%, 500V
C–318	22019–1	CAPACITOR, VARIABLE PLUNGER, 0.5 – 4.5pf, 500V
C–319	21201–229	CAPACITOR, CERAMIC TUB, 2.2pf ±0.25pf, 500V
C–320	21282–2	CAPACITOR, CERAMIC TUB., 7.5pf ±0.5%, 500V, P–100
C–321	24515–1	CAPACITOR, CERAMIC DISC, 0.1uf +80% –20%, 10V
C–322	21201–759	CAPACITOR, CERAMIC TUB., 7.5pf ± 0.5pf, 500V, NPO
C–323	21282–2	CAPACITOR, CERAMIC TUB., 7.5pf ±0.5pf, 500V, P–100
C–324	21291–6	CAPACITOR, CERAMIC DISC, .01uf, 500V, GMV
C–325	24515–7	CAPACITOR, CERAMIC, 0.05uf +80% –20%, 20V
C–326	21291–6	CAPACITOR, CERAMIC DISC, 0.01uf +80% –20%, 500V
C–327	21207–120	CAPACITOR, CERAMIC, TUB, 12pf ±10%, 500V, N–750
C–328	21207–120	CAPACITOR, CERAMIC TUB., 12pf ±10%, 500V, N–750
C–329	24515–1	CAPACITOR, CERAMIC DISC., 0.1uf +80% –20%, 10V
C–330	24515–1	CAPACITOR, CERAMIC DISC, 0.1uf +80% –20%, 10V
C–331	24509–SELECTED	CAPACITOR, CERAMIC ±5%, 500V
C–332	24515–6	CAPACITOR, CERAMIC DISC, 0.1uf +80% –20%, 20V
C–333	23091–79	CAPACITOR, CERAMIC, .22uf±10%, 75V
C–334	21207–120	CAPACITOR, CERAMIC TUB., 12pf ± 10%, 500V, N – 750
C–335	23091–79	CAPACITOR, CERAMIC, 0.22uf± 10%, 75V
C–336	23085–59	CAPACITOR, MYLAR, .0047uf ± 10%, 100V
C–337	24515–1	CAPACITOR, CERAMIC DISC, 0.1uf +80% –20%, 10V
C–338	21298–1	CAPACITOR, FEED THRU, 1000pf +100% –0%, 500V
C–339	21291–6	CAPACITOR, CERAMIC DISC, .01uf +80% –20%, 500V
C–340	24045–512	CAPACITOR, DIPPED MICA, 5100pf±5%, 300V
C–341	21298–1	CAPACITOR, FEED THRU, 1000pf +100% –0%, 500V
C–342	21555–18	CAPACITOR, SOLID TANTALUM, 22/15 22uf ±10%, 15V
C–343	21291–25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 1KV
C–344	24049–220	CAPACITOR, DIPPED MICA, 22pf ±5%, 500V
C–345	22019–1	CAPACITOR, VARIABLE PLUNGER, 0.5 – 4.5pf, 500V

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
C-346	24049-430	CAPACITOR, DIPPED MICA, 43pf ±5%, 500V
C-347	21291-25	CAPACITOR, CERAMIC DISC, 430pf ±10%, 1KV
C-348	21298-1	CAPACITOR, FEED THRU, 1000pf +100% -0%, 500V
C-349	21291-6	CAPACITOR, CERAMIC DISC, .01uf, 500V, GMV
C-350	21299-470	CAPACITOR, CERAMIC TUB., 47pf, 500V, NPO
C-351	24049-431	CAPACITOR, DIPPED MICA, 430pf ±5%, 500V
C-352	24045-122	CAPACITOR, DIPPED MICA, 1200pf ±5%, 500V
C-353	22001-312	CAPACITOR, VARIABLE, 3-12pf, 350V, NPO
C-354	21294-330	CAPACITOR, CERAMIC TUB., 33pf ±10%, 500V, N-1500
C-355	21299-SELECTED	CAPACITOR, CERAMIC TUB. ±10% 500V,
C-356	24517-1	CAPACITOR, FEED THRU, 100pf ±10%, 500V
C-357	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-358	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-359	21291-21	CAPACITOR, CERAMIC DISC, 1000pf + 20%, 1KV
C-360	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ± 20%, 1KV
C-361	21291-21	CAPACITOR, CERAMIC DISC, 1000pf ±20%, 1KV
C-362	21558-5	CAPACITOR, ELECTROLYTIC, 5uf, 10V
C-363	21298-1	CAPACITOR, FEED THRU, 1000pf ± 80% - 20%, 500V
C-364	21298-1	CAPACITOR, FEED THRU, 1000pf +80% -20%, 500V
C-365	21298-1	CAPACITOR, FEED THRU, 1000pf + 80% -20%, 500V
C-366	21554-38	CAPACITOR, ELECTROLYTIC, 40 MFD, 200V
C-367	21298-1	CAPACITOR, FEED THRU, 1000pf + 80% -20%, 500V
C-368	24049-101	CAPACITOR, DIPPED MICA, 100pf ± 5%, 500V
C-369	21554-3	CAPACITOR, ELECTROLYTIC, 200uf, 15V
C-372	21291-7	CAPACITOR, CERAMIC DISC, 470pf ± 20%, 1KV
C-373	21554-35	CAPACITOR, ELECTROLYTIC, 2MFD, 200V
C-374	21291-25	CAPACITOR, CERAMIC DISC, 430pf ± 10%, 500V
C-375	21291-6	CAPACITOR, CERAMIC DISC, .01MFD + 80% -20%, 500V
CP-101	24525-1	CIRCUIT PLATE COMM. DETECTOR
CP-301	24524-1	CIRCUIT NAV. DETECTOR
CP-302	24526-1	CIRCUIT PLATE AUDIO COMBINER
CR-101	75013-5	DIODE, SILICON
CR-102	75019-2	DIODE, SILICON
CR-103	75013-4	DIODE, SILICON
CR-104	75013-4	DIODE, SILICON
CR-105	75025-2	DIODE-ZENER, 8.2V, ±10%, 1W
CR-201	75021-2	DIODE, SILICON
CR-202	75021-2	DIODE, SILICON
CR-301	75019-2	DIODE, SILICON
CR-302	75013-4	DIODE, SILICON
CR-303	75013-4	DIODE, SILICON
I-101	12000-20	LAMP #53 CLEAR
I-102	12000-20	LAMP #53 CLEAR
J-101	41110-2	CONNECTOR, ANTENNA, COMM.
J-301	41143-1	CONNECTOR, ANTENNA, NAV
P-101	41181-3	CONNECTOR, 16 PIN MALE
P-301	41117-1	CONNECTOR, 6 PIN FEMALE

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
L–101	11135–9	CHOKE, ANTENNA FILTER, .09 uhy
L–102	11135–9	CHOKE, ANTENNA FILTER, .09 uhy
L–103	61378–101	STEP INDUCTOR
L–104	11273–26	COIL, ANT. COMM. REC.
L–105	61378–101	STEP INDUCTOR
L–106	11412–123	COIL, RF PLATE, COMM.
L–107	61378–101	STEP INDUCTOR
L–108	11412–129	COIL, MIXER, COMM.
L–109	61406–1	STEP INDUCTOR, HF, IF, COMM.
L–110	61406–1	STEP INDUCTOR, HF, IF, COMM.
L–111	61406–1	STEP INDUCTOR, HF, IF, COMM.
L–112	11138–9	CHOKE, INSULATED, 2.2 uhy ± 10%
L–113	11138–9	CHOKE, INSULATED, 2.2 uhy ± 10%
L–114	11138–9	CHOKE, INSULATED, 2.2 uhy ± 10%
L–116	11138–6	CHOKE, INSULATED, 0.68 uhy ±10%
L–201	61378–101	STEP INDUCTOR
L–202	11627–1	COIL, FINAL TANK
L–203	11138–6	CHOKE, INSULATED, 0.68 uhy ± 10%
L–204	11138–8	CHOKE, INSULATED, 1.5 uhy ± 10%
L–205	61378–101	STEP INDUCTOR
L–206	11138–9	CHOKE, INSULATED, 2.2 uhy ± 10%
L–207	11495–1	COIL, SECOND BUFFER
L–208	11138–8	CHOKE, INSULATED, 1.5 uhy ±10%
L–209	61378–101	STEP INDUCTOR
L–210	11138–6	CHOKE, INSULATED, 0.68 uhy ± 10%
L–211	11412–134	COIL, FIRST BUFFER
L–212	61378–101	STEP INDUCTOR
L–213	11138–9	CHOKE, INSULATED, 2.2 uhy ± 10%
L–214	11503–7	COIL, MIXER
L–215	11503–5	COIL DOUBLER
L–216	61393–101	STEP INDUCTOR, DOUBLER
L–217	11138–9	CHOKE, INSULATED, 2.2 uhy ± 10%
L–218	11412–112	COIL, COMM, HFO
L–219	61393–101	STEP INDUCTOR OSC.
L–220	11451–46	CHOKE, INSULATED, 200 uhy ± 5%
L–221	11138–7	CHOKE, INSULATED, 1.0 uhy ± 10%
L–222	11138–9	CHOKE, INSULATED, 2.2 uhy ± 10%
L–224	11138–14	CHOKE, INSULATED, 5.6 uhy ± 10%
L–225	11138–6	CHOKE, INSULATED, 0.68 uhy ± 10%
L–301	11273–22	COIL, ANTENNA
L–302	61386–1	STEP INDUCTOR
L–303	11138–27	CHOKE, INSULATED, 0.09 uhy ± 10%
L–304	61386–1	STEP INDUCTOR
L–305	11138–27	CHOKE, INSULATED, 0.09 uhy ± 10%
L–306	61386–1	STEP INDUCTOR
L–307	61407–1	STEP INDUCTOR, HF IF
L–308	61407–1	STEP INDUCTOR, HF IF
L–309	11138–2	CHOKE, INSULATED, 0.15 uhy ± 20%
L–310	11503–6	COIL, NAV. HFO

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
L-311	61 386-1	STEP INDUCTOR
L-312	11359-20	CHOKE, INSULATED, 3 9 uhy ± 10%
L-313	11138-28	CHOKE, INSULATED, 0.47 uhy ± 5%
L-314	11273-21	COIL, LFO
L-315	61384-1	STEP INDUCTOR, LFO
L-316	11135-10	CHOKE, ANTENNA FILTER, 0.047 uhy
L-317	11446-3	INDUCTOR ADJUSTABLE CENTER TAPPED
L-318	11135-10	CHOKE, ANTENNA FILTER, .047 uhy
Q-101	75568-2	TRANSISTOR, SILICON, NPN
Q-201	75568-2	TRANSISTOR, SILICON, NPN
Q-202	75568-2	TRANSISTOR, SILICON, NPN
Q-203	75550-7	TRANSISTOR, SILICON PLANAR, NPN 2N3391
Q-301	75568-2	TRANSISTOR, SILICON, NPN
Q-302	75550-7	TRANSISTOR, SILICON, NPN
Q-303	75568-2	TRANSISTOR, SILICON, NPN
Q-304	75550-7	TRANSISTOR, SILICON, NPN
Q-305	75578-1	FET TRANSISTOR SILICON
R-101	31141-103	RESISTOR, CARBON, 10K ± 10%, 1/2W
R-102	31141-473	RESISTOR, CARBON, 47K ± 10%, 1/2W
R-103	31141-221	RESISTOR, CARBON, 220 ± 10%, 1/2W
R-104	31141-151	RESISTOR, CARBON 150 ±10%, 1/2W
R-105	31141-473	RESISTOR, CARBON 47K ±10%, 1/2W
R-106	31141-104	RESISTOR, CARBON, 1 00K ± 10%, 1/2W
R-107	31141-104	RESISTOR, CARBON, 100K ±10%, 1/2W
R-1 08	31141-151	RESISTOR, CARBON 150 ± 10%, 1/2W
R-109	31141-821	RESISTOR, CARBON, 820 ±10%, 1/2W
R-110	31141-470	RESISTOR, CARBON, 47 ± 10%, 1/2W
R-111	31141-104	RESISTOR, CARBON , 100K ±10%, 1/2W
R-112	31141-151	RESISTOR, CARBON , 150 ± 10%, 1/2W
R-115	31141-102	RESISTOR, CARBON, 1K ± 10%, 1/2W
R-116	31141-103	RESISTOR, CARBON, 10K ±10%, 1/2W
R-117	31141-151	RESISTOR, CARBON 150 ± 10%, 1/2W
R-119	31141-471	RESISTOR, CARBON, 470 ± 10%, 1/2W
R-120	31141-473	RESISTOR, CARBON, 47K ± 10%, 1/2W
R-121	31141-151	RESISTOR, CARBON, 150 ± 10%, 1/2W
R-122	31192-222	RESISTOR, CARBON, 2.2K ± 10%, 1/4W
R-123	31192-565	RESISTOR, CARBON 5.6K ± 10%, 1/4W
R-124	31192-151	RESISTOR, CARBON, 150 ± 10%, 1/4W
R-125	32040-4	POT., 1 MEG, VOL. CONT/SW.
R-127	31141-471	RESISTOR, CARBON, 470 ± 10%, 1/2W
R-128	31136-470	RESISTOR, CARBON, 47 ±10%, 2W
R-129	31141-271	RESISTOR, CARBON, 270 ± 10%, 1/2W
R-130	31141-271	RESISTOR, CARBON , 270 ±10%, 1 /2W
R-131	31141-333	RESISTOR, CARBON , 33K ±10%, 1/2W
R-132	32055-5	POT., 50K, SQUELCH
R-133	31141-104	RESISTOR, CARBON, 100K ± 10%, 1/2W
R-134	31141-820	RESISTOR, CARBON 82 ± 10%, 1/2W
R-135	31141-561	RESISTOR, CARBON, 560 ±10%, 1/2W
R-136	31136-151	RESISTOR, CARBON, 1 50 ± 10%, 2W
R-137	31141-102	RESISTOR, CARBON, 1000± 10%, 1/2W
R-138	31192-101	RESISTOR, CARBON, 100± 10%, 1/4W
R-139	31141-330	RESISTOR, CARBON, 33 ± 10%, 1/2W

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
R–201	31141–104	RESISTOR, CARBON 100K ± 10%, 1/2W
R–202	31135–822	RESISTOR, CARBON 8.2K ± 10%, 1W
R–203	31161–8	RESISTOR, WIREWOUND, 200 ± 5%, 3W
R–204	31141–683	RESISTOR, CARBON, 68K ±10%, 1/2W
R–205	31141–223	RESISTOR, CARBON, 22K ± 10%, 1/2W
R–206	31141–470	RESISTOR, CARBON, 47 ± 10%, 1/2W
R–207	31135–153	RESISTOR, CARBON, 15K± 10%, 1W
R–208	31141–101	RESISTOR, CARBON 100 ± 10%, 1/2W
R–209	31141–183	RESISTOR, CARBON, 18K ± 10%, 1/2W
R–210	31141–470	RESISTOR, CARBON, 47 ± 10%, 1/2W
R–211	31135–182	RESISTOR, CARBON, 1.8K ± 10%, 1W
R–212	31141–330	RESISTOR, CARBON, 33 ± 10%, 1/2W
R–213	31192–101	RESISTOR, CARBON, 100 ± 10%, 1/4W
R–214	31192–103	RESISTOR, CARBON, 10K ± 10%, 1/4W
R–215	31192–274	RESISTOR, CARBON, 270K ±10%, 1/4W
R–216	31192–101	RESISTOR, CARBON, 100 ±10%, 1/4W
R–217	31192–221	RESISTOR, CARBON, 220 ± 10%, 1/4W
R–218	31192–470	RESISTOR, CARBON, 47 ±10%, 1/4W
R–219	31192–332	RESISTOR, CARBON, 3.3K ± 10%, 1/4W
R–220	31192–561	RESISTOR, CARBON, 560 ± 10%, 1/4W
R–221	31192–152	RESISTOR, CARBON, 1.5K ± 10%, 1/4W
R–223	31192–103	RESISTOR, CARBON, 10K ± 10%, 1/4W
R–224	31192–151	RESISTOR, CARBON, 150 ± 10%, 1/4W
R–225	31192–153	RESISTOR, CARBON, 15K ± 10K, 1/4W
R–226	31192–153	RESISTOR, CARBON, 15K ± 10%, 1/4W
R–227	31135–393	RESISTOR, CARBON, 39K ± 10%, 1W
R–228	31135–273	RESISTOR, CARBON, 27K ± 10%, 1W
R–229	31135–273	RESISTOR, CARBON, 27K ± 10%, 1W
R–230	31192–103	RESISTOR, CARBON, 10K ± 10%, 1/4W
R–231	31192–103	RESISTOR, CARBON, 10K ± 10%, 1/4W
R–232	31192–222	RESISTOR, CARBON, 2.2K ±10%, 1/4W
R–233	31192–102	RESISTOR, CARBON, 1K ± 10%, 1/4W
R–234	31161–20	RESISTOR, WIREWOUND, 150 ± 5%, 3W
R–235	31192–101	RESISTOR, CARBON, 100 ± 10%, 1/4W
R–236	31192–680	RESISTOR, CARBON, 68 ± 10%, 1/4W
R–237	31175–18	RESISTOR, WIREWOUND, 1 5K ± 5%, 7W
R–238	31192–680	RESISTOR, CARBON, 68 ± 10%, 1/4W
R–239	31192–683	RESISTOR, CARBON, 68K ± 10%, 1/4W
R–302	31141–221	RESISTOR, CARBON, 220 ± 10%, 1/2W
R–303	31141–104	RESISTOR, CARBON, 100K ± 10%, 1/2W
R–304	31141–223	RESISTOR, CARBON, 22K ± 10%, 1/2W
R–305	31141–151	RESISTOR, CARBON, 150 ± 10%, 1/2W
R–306	31141–104	RESISTOR. CARBON. 100K ± 10%, 1/2W
R–307	31141–471	RESISTOR, CARBON, 470 ± 10%, 1/2W
R–308	31141–104	RESISTOR, CARBON, 100K ± 10%, 1/2W
R–309	31192–681	RESISTOR, CARBON, 680 ± 10%, 1/4W
R–310	31141–151	RESISTOR, CARBON, 150 ± 10%, 1/2W
R–311	31141–102	RESISTOR, CARBON. 1K ± 10%, 1/2W

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
R-312	31192-471	RESISTOR, CARBON, 470 ± 10%, 1/4W
R-313	31192-222	RESISTOR, CARBON, 2.2K ± 10%, 1/4W
R-314	31192-153	RESISTOR, CARBON, 15K ±10%, 1/4W
R-315	31141-685	RESISTOR, CARBON, 6.8 MEG. ± 10%, 1/2W
R-316	31192-680	RESISTOR, CARBON, 68 ± 10%, 1/4W
R-317	31141-474	RESISTOR, CARBON, 470K ±10%, 1/2W
R-318	32040-5	POTENTIOMETER, 1 MEG. VOL. CONT 1/2W
R-319	31192-683	RESISTOR, CARBON, 68K ± 10%, 1/4W
R-320	31192-683	RESISTOR, CARBON, 68K ± 10%, 1/4W
R-321	31141-153	RESISTOR, CARBON, 15K ± 10%, 1/2W
R-322	31192-392	RESISTOR, CARBON, 3.9K ± 10%, 1/4W
R-323	31141-681	RESISTOR, CARBON, 680 ± 10%, 1/2W
R-324	31141-222	RESISTOR, CARBON, 2.2K ± 10%, 1/2W
R-325	31192-152	RESISTOR, CARBON, 1.5K ± 10%, 1/4W
R-326	31192-332	RESISTOR, CARBON, 3.3K ± 10%, 1/4W
R-327	31192-561	RESISTOR, CARBON, 560 ± 10%, 1/4W
R-328	31192-101	RESISTOR, CARBON, 100 ± 10%, 1/4W
R-329	31135-153	RESISTOR, CARBON, 15K ±10%, 1W
R-330	31141-153	RESISTOR, CARBON, 15K ± 10%, 1/2W
R-331	31192-681	RESISTOR, CARBON, 680 ± 10%, 1/4W
R-332	31192-222	RESISTOR, CARBON, 2.2K ± 10%, 1/4W
R-333	31192-153	RESISTOR, CARBON, 15K ± 10%, 1/4W
R-334	31192-151	RESISTOR, CARBON, 150 ± 10%, 1/4W
R-335	31192-103	RESISTOR, CARBON, 10K ± 10%, 1/4W
R-336	31192-680	RESISTOR, CARBON, 68 ± 10%, 1/4W
R-337	31192-103	RESISTOR, CARBON, 10K ± 10%, 1/4W
R-338	31192-101	RESISTOR, CARBON, 100 ± 10%, 1/4W
R-339	31192-222	RESISTOR, CARBON, 2.2K ± 10%, 1/4W
R-340	31192-100	RESISTOR, CARBON, 10 ± 10%, 1/4W
R-341	31141-151	RESISTOR, CARBON, 150 ± 10%, 1/2W
R-343	31192-564	RESISTOR, CARBON, 560K ± 10%, 1/4W
R-344	31192-154	RESISTOR, CARBON, 150K ± 10%, 1/4W
R-345	31192-SELECTED	RESISTOR, CARBON, ± 10%, 1/4W
R-346	31192-330	RESISTOR, CARBON, 330 ± 10%, 1/4W
R-347	31192-562	RESISTOR, CARBON, 5.6K ± 10%, 1/4W
R-348	31192-222	RESISTOR, CARBON, 2.2K ± 10%, 1/4W
R-349	31192-683	RESISTOR, CARBON, 68K ± 10%, 1/4W
R-350	31192-223	RESISTOR, CARBON, 22K ± 10%, 1/4W
R-351	31192-151	RESISTOR, CARBON, 150 ± 10%, 1/4W
R-352	31141-125	RESISTOR, CARBON, 1.2 MEG ± 10%, 1/2W
S-101		PART OF R-125
S-102		PART OF R-125
S-103		PART OF L-103
S-105		PART OF L-105
S-107		PART OF L-107
S-109		PART OF L-109
S-110		PART OF L-110
S-111		PART OF L-111

MARK 12B PANEL UNIT, Electrical Parts Continued

Symbol or Item No.	Part No.	Description
S–201		PART OF L–201
S–202	61395–1	SWITCH, XTAL, HFO, COMM. (FRONT)
S–203	61396–1	SWITCH, XTAL, HFO, COMM. (REAR)
S–204		PART OF S–220
S–205		PART OF L–205
S–209		PART OF L–209
S–212		PART OF L–212
S–216		PART OF L–216
S–219		PART OF L–219
S–220	61409–101	SWITCH ASSY., XTAL, SEL. KHz
S–301	61389–1	SWITCH, XTAL, HFO NAV.
S–302		PART OF L–302
S–303	61389–1	SWITCH
S–304		PART OF L–304
S–305	61483–1	SWITCH LOC/G.S. MHz
S–306		PART OF L–306
S–307		PART OF L–307
S–308		PART OF L–308
S–309	61482–1	SWITCH DME MHz
S–310	61425–2	SWITCH LOC/GS/DME KHz
S–311		PART OF L–311
S–312	61426–1	SWITCH LOC/GS/DME KHz
S–313		PART OF R–318
S–315		PART OF L–315
T–101	11497–1	TRANSFORMER, COMM. HF IF INPUT
T–102	11502–1	TRANSFORMER, COMM. HF IF OUTPUT
T–103	11671–101	TRANSFORMER, COMM. LF IF INPUT
T–104	11500–1	TRANSFORMER, COMM. LF IF INTERSTAGE
T–105	11496–1	TRANSFORMER, COMM. LF IF CUTPUT
T–201	11505–1	TRANSFORMER, COMM LFO
T–301	11672–101	TRANSFORMER, NAV. HF IF
T–302	11499–1	TRANSFORMER, NAV. LF IF INPUT
T–303	11498–1	TRANSFORMER, NAV. LF IF OUTPUT
V–101	6BH6	TUBE, ELECTRON
V–102	6AK5	TUBE, ELECTRON
V–103	6EA8	TUBE ELECTRON
V–104	6BJ6	TUBE, ELECTRON
V–201	7551	TUBE, ELECTRON
V–202	8106	TUBE, ELECTRON
V–203	8106	TUBE, ELECTRON
V–204	75401–2	TUBE, ELECTRON, 6AR8 (SPECIAL)
V–301	6BJ6	TUBE, ELECTRON
V–302	6CB6	TUBE, ELECTRON
V–303	6CB6	TUBE, ELECTRON
V–304	6CW4	TUBE, ELECTRON

SYMBOL	NARCO PART NO.	DESCRIPTION	FOR MHz DIAL SETTING	FUNCTION OR APPLICATION
XT-101	72007-235	Crystal quartz submin. 63.2375 MHz	117 MHz	Com. Transceiver
XT-102	72007-236	Crystal quartz submin. 63.7375 MHz	118 MHz	Com. Transceiver
XT-103	72007-237	Crystal quartz submin. 64.2375 MHz	119 MHz	Com. Transceiver
XT-104	72007-238	Crystal quartz submin. 64.7375 MHz	120 MHz	Com. Transceiver
XT-105	72007-239	Crystal quartz submin. 65.2375 MHz	121 MHz	Com. Transceiver
XT-106	72007-240	Crystal quartz submin. 65.7375 MHz	122 MHz	Com. Transceiver
XT-107	72007-241	Crystal quartz submin. 66.2375 MHz	123 MHz	Com. Transceiver
XT-108	72007-242	Crystal quartz submin. 66.7375 MHz	124 MHz	Com. Transceiver
XT-109	72007-243	Crystal quartz submin. 67.2375 MHz	125 MHz	Com. Transceiver
XT-110	72007-244	Crystal quartz submin. 67.7375 MHz	126 MHz	Com. Transceiver
XT-111	72007-245	Crystal quartz submin. 68.2375 MHz	127 MHz	Com. Transceiver
XT-112	72007-246	Crystal quartz submin. 68.7375 MHz	128 MHz	Com. Transceiver
XT-113	72007-247	Crystal quartz submin. 69.2375 MHz	129 MHz	Com. Transceiver
XT-114	72007-248	Crystal quartz submin. 69.7375 MHz	130 MHz	Com. Transceiver
XT-115	72007-249	Crystal quartz submin. 70.2375 MHz	131 MHz	
XT-116	72007-250	Crystal quartz submin. 70.7375 MHz	132 MHz	Com. Transceiver
XT-117	72007-251	Crystal quartz submin. 71.2375 MHz	133 MHz	Com. Transceiver
XT-118	72007-252	Crystal quartz submin. 71.7375 MHz	134 MHz	Com. Transceiver
XT-119	72007-253	Crystal quartz submin. 72.2375 MHz	135 MHz	Com. Transceiver
XT-120	72007-254	Crystal quartz submin. 9.475 MHz	.00 MHz	Com. Transceiver
XT-121	72007-255	Crystal quartz submin. 9.425 MHz	.05 MHz	Com. Transceiver
XT-122	72007-256	Crystal quartz submin. 9.375 MHz	.10 MHz	Com. Transceiver
XT-123	72007-257	Crystal quartz submin. 9.325 MHz	.15 MHz	Com. Transceiver
XT-124	72007-258	Crystal quartz submin. 9.275 MHz	.20 MHz	Com. Transceiver
XT-125	72007-259	Crystal quartz submin. 9.225 MHz	.25 MHz	Com. Transceiver
XT-126	72007-260	Crystal quartz submin. 9.175 MHz	.30 MHz	Com. Transceiver
XT-127	72007-261	Crystal quartz submin. 9.125 MHz	.35 MHz	Com. Transceiver
XT-128	72007-262	Crystal quartz submin. 9.075 MHz	.40 MHz	Com. Transceiver
XT-129	72007-263	Crystal quartz submin. 9.025 MHz	.45 MHz	Com. Transceiver
XT-130	72007-264	Crystal quartz submin. 8.975 MHz	.50 MHz	Com. Transceiver
XT-131	72007-265	Crystal quartz submin. 8.925 MHz	.55 MHz	Com. Transceiver
XT-132	72007-266	Crystal quartz submin. 8.875 MHz	.60 MHz	Com. Transceiver
XT-133	72007-267	Crystal quartz submin. 8.825 MHz	.65 MHz	Com. Transceiver
XT-134	72007-268	Crystal quartz submin. 8.775 MHz	.70 MHz	Com. Transceiver
XT-135	72007-269	Crystal quartz submin. 8.725 MHz	.75 MHz	Com. Transceiver
XT-136	72007-270	Crystal quartz submin. 8.675 MHz	.80 MHz	Com. Transceiver
XT-137	72007-271	Crystal quartz submin. 8.625 MHz	.85 MHz	Com. Transceiver
XT-138	72007-272	Crystal quartz submin. 8.575 MHz	.90 MHz	Com. Transceiver
XT-139	72007-273	Crystal quartz submin. 8.525 MHz	.95 MHz	Com. Transceiver
XT-140	72007-274	Crystal quartz submin. 96.550 MHz	108 MHz	Com. Transceiver
XT-141	72007-275	Crystal quartz submin. 97.550 MHz	109 MHz	Com. Transceiver
XT-142	72007-276	Crystal quartz submin. 98.550 MHz	110 MHz	Com. Transceiver
XT-143	72007-277	Crystal quartz submin. 99.550 MHz		Com. Transceiver
XT-144	72007-278	Crystal quartz submin. 100.550 MHz	112 MHz	Com. Transceiver
XT-145	72007-279	Crystal quartz submin. 101.550 MHz	113 MHz	Com. Transceiver
XT-146	72007-280	Crystal quartz submin. 102.550 MHz	114 MHz	Com. Transceiver
XT-147	72007-281	Crystal quartz submin. 103.550 MHz	115 MHz	Com. Transceiver
XT-148	72007-282	Crystal quartz submin. 104.550 MHz	116 MHz	Com. Transceiver
XT-149	72007-283	Crystal quartz submin. 105.550 MHz	117 MHz	Com. Transceiver

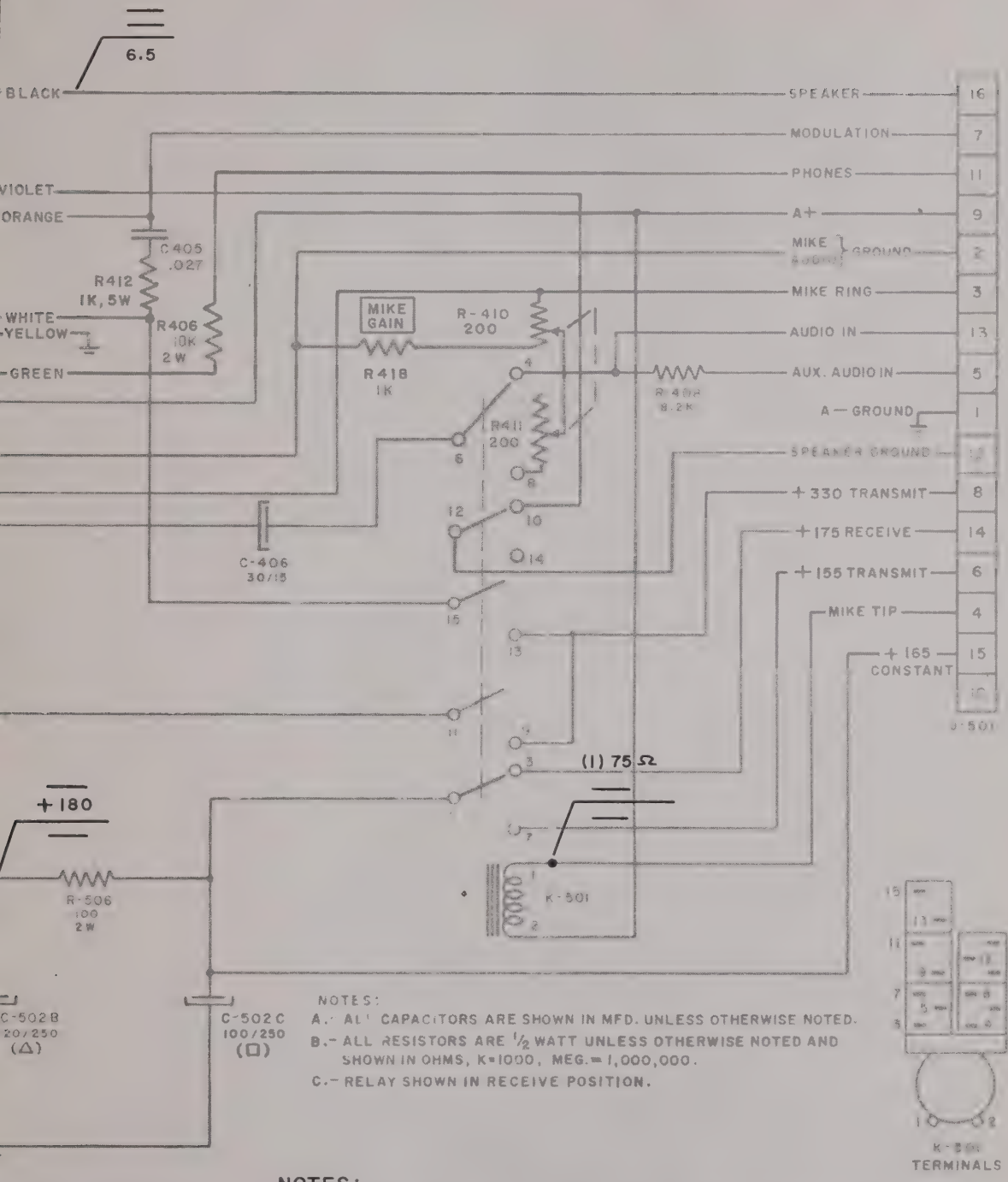
This Section of the Replacement Parts List provides a listing of all the replaceable parts of the Modulator-Power Units MP-12A-1 and MP-12AH-1 both 14 and 28 volts.

Due to the similarity between Units, all Units have been combined into one list. The Used On Column indicates which Unit the particular part is used on. When ALL is indicated, it means that the part is common to all the units described in the list heading. See Figures 6-1 thru 6-4 for part location.

Modulator-Power Unit		Used On	See Figure
T (12) MP-12-A1	14V	A	6-1
T (24) MP-12-A1	28V	B	6-2
T (12) MP-12-AH-1	14V	C	6-3
T (24) MP-12-AH-1	28V	D	6-4

Item or Symbol No.	Narco Part No.	Description	Used On
		Mechanical Parts	
1	04238-9	Label, T(12)MP12A-1	A
1	04238-10	Label, T(24)MP12A-1	B
1	04238-11	Label, T(12)MP-12AH-1	C
1	04238-12	Label, T(24)MP-12AH-1	D
2	04139-3	Label, Warning	ALL
3	04284-1	Label, Mike Adjustment	ALL
4	56438-1	Cover, Dust (not shown)	ALL
5	56492-1	Chassis	ALL
6	56491-1	Panel, Front	ALL
7	56438-1	Panel, Rear	ALL
8	55020-2	Insulator, Transistor	ALL
9	56490-1	Shelf	ALL
10	81213-6	Spacer, Trans. Mount	ALL
11	81440-5	Tie Lug Strip, 10 Lug	ALL
12	81442-10	Tie Lung Strip, 6 Lug	ALL
13	81436-6	Tie Lug Strip, 9 Lug	ALL
14	81335-11	Insulator, Shoulder	ALL
15	81443-1	Tie Lug Strip, 5 Lug	ALL
16	81435-13	Tie Lug Strip, 8 Lug	ALL
17	81436-5	Tie Lug Strip, 9 Lug	ALL
18	81436-9	Tie Lug Strip, 9 Lug	ALL
19	66507-1	Fuseholder	ALL
20	82010-20	Clamp, Cable	ALL
21	56489-1	Bar, Pot Ganging	ALL
22	81213-65	Spacer, Pot Mounting	ALL
23	81213-64	Spacer, Sub-chassis	ALL

Item or Symbol No.	Narco Part No.	Description	Used on
		Electrical Parts	
C-401	21554-3	CAPACITOR, ELECTROLYTIC, 200 mfd, 15V	ALL
C-405	23078-273	CAPACTOR, MYLAR, .027 mfd ±5%, 1000V	ALL
C-406	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	ALL
C-408	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	C, D
C-501	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	ALL
C-502	21556-1	CAPACITOR, ELECTROLYTIC, 40 mfd, 475V, 100 mfd, 250V, 20 mfd, 250V	ALL
C-505	23086-19	CAPACITOR, MYLAR, 2.0 mfd, 200V	ALL
C-506	21525-29	CAPACITOR, ELECTROLYTIC, 500 mfd, 35V	ALL
C-509	21554-3	CAPACITOR, ELECTROLYTIC, 200 mfd, 15V	C, D
CR-501	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-502	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-503	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-504	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-505	75204-45	DIODE, SILICON, 500 PIV	ALL
F-501	66504-12	FUSE, SLO/BLO, 10 amp	A, C
F-501	66504-10	FUSE, SLO/BLO, 6¼ amp	B, D
J-501	41181-4	CONNECTOR, PLUG, 16 pin	ALL
K-501	65126-23	RELAY	A, B
K-502	65134-1	RELAY	C, D
K-503	65134-2	RELAY	C, D
L-401	11814-3	INDUCTOR, FILTER	ALL
L-501	11449-1	CHOKE, 50 μh	ALL
Q-401	75571-2	TRANSISTOR, DRIVER	ALL
Q-402	75534-3	TRANSISTOR, AUDIO, OUTPUT	A, C
Q-402	75544-2	TRANSISTOR, AUDIO, OUTPUT	B, D
Q-403	75534-3	TRANSISTOR, AUDIO, OUTPUT	A, C
Q-403	75544-2	TRANSISTOR, AUDIO, OUTPUT	B, D
Q-501	75564-2	TRANSISTOR, POWER	ALL
Q-502	75564-2	TRANSISTOR, POWER	ALL
R-401	31141-103	RESISTOR, FIXED, COMPOSITION, 10K ±10%, ½W	ALL
R-402	31141-472	RESISTOR, FIXED, COMPOSITIOIN, 4.7K ±10%, ½W	ALL
R-403	31187-1	RESISTOR, TEMPERATURE, SENSITIVE, 0.24 ohm ±10%, +T.C.	A, C
R-403	31179-1	RESISTOR, TEMPERATURE, SENSITIVE, 0.47 ohm ±10%, +T.C.	B, D
R-404	31141-471	RESISTOR, FIXED,COMPOSITION, 470 ohm ±10%, ½W	ALL
R-405	31141-689	RESISTOR, FIXED, COMPOSITION, 6.8 ohm ±10%, ½W	A, C
R-405	31141-829	RESISTOR, FIXED, COMPOSITION, 8.2 ohm ±10%, ½W	B, D
R-406	31136-103	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 2W	ALL
R-408	31141-822	RESISTOR, FIXED, COMPOSITION, 8.2K ±10%, ½W	A, B
R-408	31141-471	RESISTOR, FIXED, COMPOSITION, 470 ohm ±10%, ½W	C, D
R-409	31175-11	RESISTOR, WIREWOUND, 75 ohm ±5%, 5W	B, D
R-410	32045-13	RESISTOR, VARIABLE, Wirewound, 200 ohm, 2W	ALL
R-411	32045-13	RESISTOR, VARIABLE, Wirewound, 200 ohm, 2W	ALL
R-412	31175-22	RESISTOR, WIREWOUND, 1K ohm ±10%, 5W	ALL
R-413	31141-332	RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, ½W	C, D
R-414	31141-220	RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, ½W	C, D
R-415	31141-100	RESISTOR, FIXED, COMPOSITION, 10 ohm ±10%, ½W	A, C
R-415	31141-180	RESISTOR, FIXED, COMPOSITION, 18 ohm ±10%, ½W	B, D
R-416	31141-102	RESISTOR, FIXED, COMPOSITION, 1K ±10%, ½W	A, C
R-416	31141-331	RESISTOR, FIXED, COMPOSITION, 330 ohm ±10%, ½W	B, D
R-417	33002-109	RESISTOR, WIRE ADJUSTABLE, 1 ohm, 10W	A, C
R-417	33002-309	RESISTOR, WIRE ADJUSTABLE, 3 ohm, 10W	B, D
R-418	31141-102	RESISTOR, FIXED, COMPOSITION, 1K ±10%, ½W	ALL
R-501	31136-471	RESISTOR, FIXED, COMPOSITION, 470 ohm ±10%, 2W	ALL
R-502	31175-24	RESISTOR, WIREWOUND, 10 ohm ±10%, 7W	A, C
R-502	31136-220	RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, 2W	B, D
R-503	31141-229	RESISTOR, FIXED, COMPOSITION, 2.2 ohm ±10%, ½W	A, C
R-505	31135-274	RESISTOR, FIXED, COMPOSITION, 270K ±10%, 1W	ALL
R-506	31136-101	RESISTOR, FIXED, COMPOSITION, 100 ohm ±10%, 2W	ALL
R-507	31175-11	RESISTOR, WIREWOUND, 75 ohm ±5%, 5W	B
R-511	31157-6	RESISTOR, WIREWOUND, 42 ohm ±5%, 7W	D
T-401	11706-2	TRANSFORMER, AUDIO, Transistor Driver	ALL
T-402	11704-2	TRANSFORMER, AUDIO, OUTPUT, 14 Volt	A, C
T-402	11705-2	TRANSFORMER, AUDIO OUTPUT, 28 Volt	B, D
T-501	11697-1	TRANSFORMER, POWER, 14 Volt	A, C
T-501	11698-1	TRANSFORMER, POWER, 28 Volt	B, D



TEST DATA

DC RESISTANCE

DC VOLTAGE & POLARITY

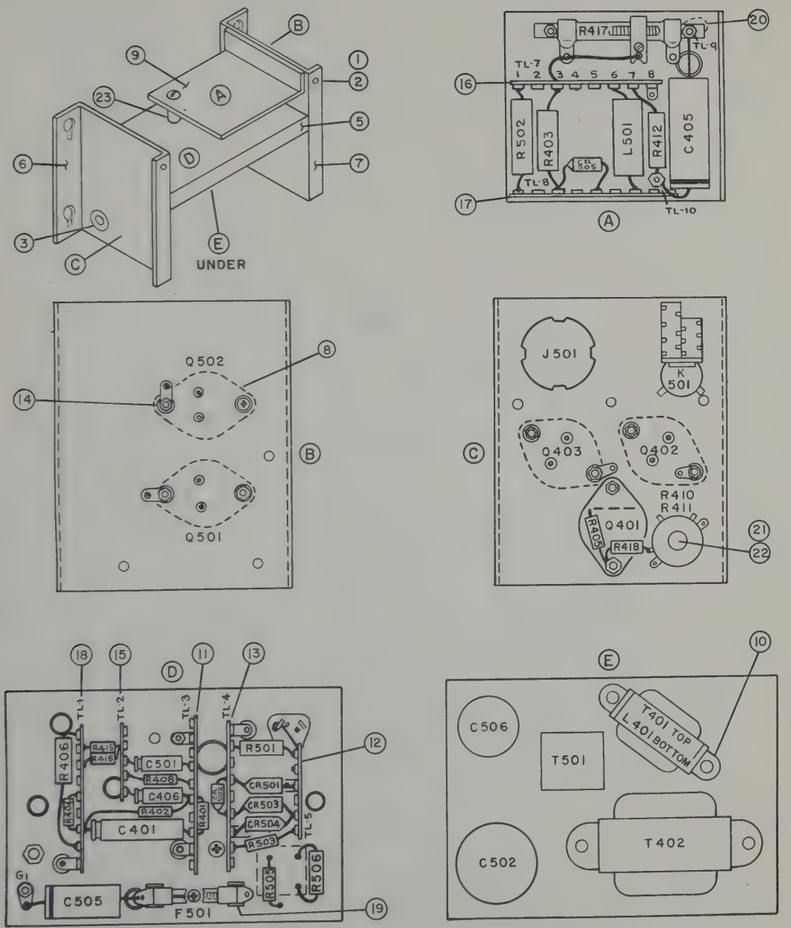
AC VOLTAGE OR WAVESHAPE & P-P VOLTAGE

NOTES:

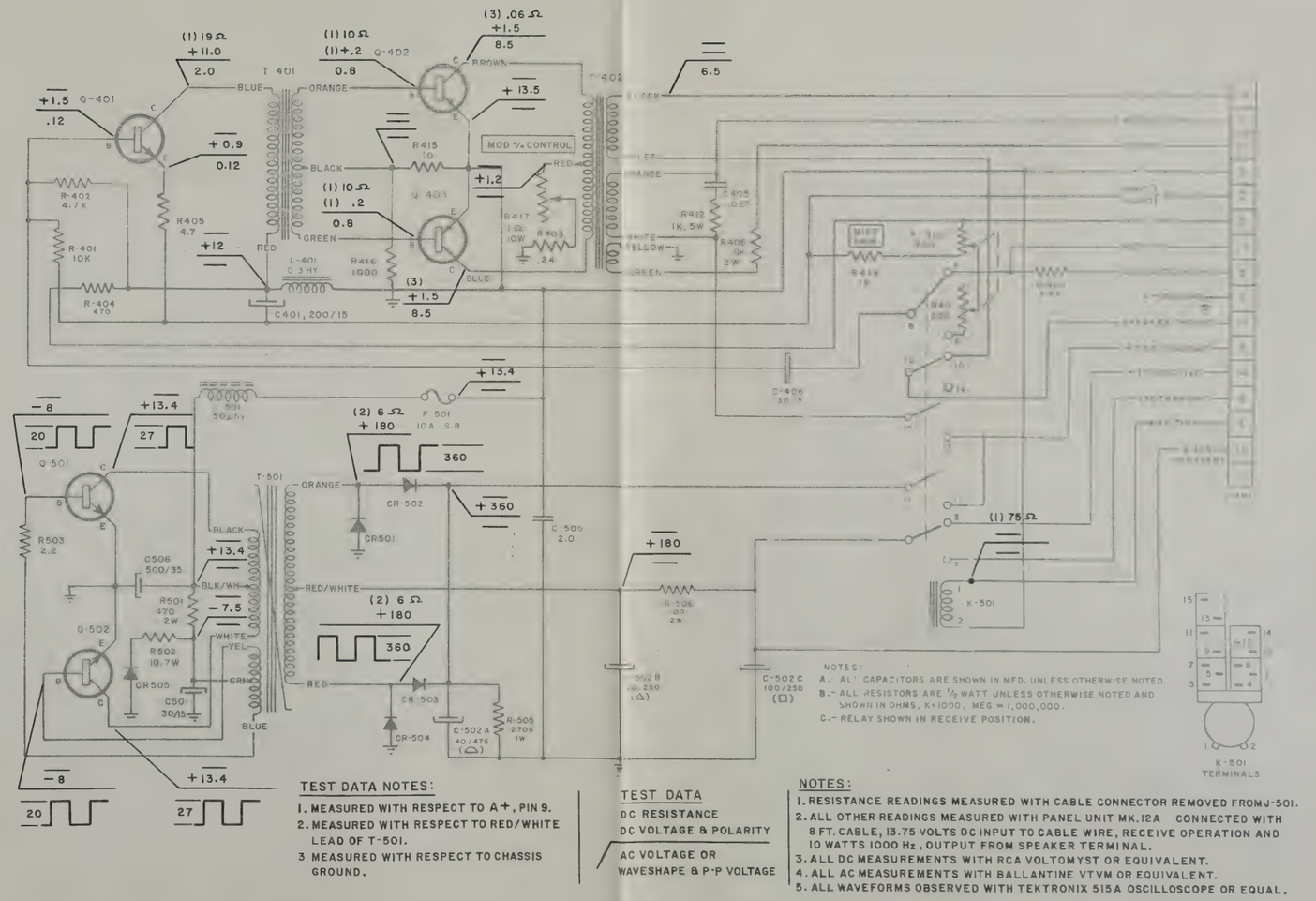
1. RESISTANCE READINGS MEASURED WITH CABLE CONNECTOR REMOVED FROM J-501.
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 13.75 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000 Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE VTVM OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

Figure 6-1 MODULATOR-POWER UNIT, T(12) MP-12A-1 (Drawing and Schematic)

Item or Symbol No.	Narco Part No.	Description	Used on
		Electrical Parts	
C-401	21554-3	CAPACITOR, ELECTROLYTIC, 200 mfd, 15V	ALL
C-405	23078-273	CAPACTOR, MYLAR, .027 mfd ±5%, 1000V	ALL
C-406	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	ALL
C-408	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	C, D
C-501	21552-18	CAPACITOR, ELECTROLYTIC, 30 mfd, 15V	ALL
C-502	21556-1	CAPACITOR, ELECTROLYTIC, 40 mfd, 475V, 100 mfd, 250V, 20 mfd, 250V	ALL
C-505	23086-19	CAPACITOR, MYLAR, 2.0 mfd, 200V	ALL
C-506	21525-29	CAPACITOR, ELECTROLYTIC, 500 mfd, 35V	ALL
C-509	21554-3	CAPACITOR, ELECTROLYTIC, 200 mfd, 15V	C, D
CR-501	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-502	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-503	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-504	75204-45	DIODE, SILICON, 500 PIV	ALL
CR-505	75204-45	DIODE, SILICON, 500 PIV	ALL
F-501	66504-12	FUSE, SLO/BLO, 10 amp	A, C
F-501	66504-10	FUSE, SLO/BLO, 6¼ amp	B, D
J-501	41181-4	CONNECTOR, PLUG, 16 pin	ALL
K-501	65126-23	RELAY	A, B
K-502	65134-1	RELAY	C, D
K-503	65134-2	RELAY	C, D
L-401	11814-3	INDUCTOR, FILTER	ALL
L-501	11449-1	CHOKE, 50 μh	ALL
Q-401	75571-2	TRANSISTOR, DRIVER	ALL
Q-402	75534-3	TRANSISTOR, AUDIO, OUTPUT	A, C
Q-402	75544-2	TRANSISTOR, AUDIO, OUTPUT	B, D
Q-403	75534-3	TRANSISTOR, AUDIO, OUTPUT	A, C
Q-403	75544-2	TRANSISTOR, AUDIO, OUTPUT	B, D
Q-501	75564-2	TRANSISTOR, POWER	ALL
Q-502	75564-2	TRANSISTOR, POWER	ALL
R-401	31141-103	RESISTOR, FIXED, COMPOSITION, 10K ±10%, ½W	ALL
R-402	31141-472	RESISTOR, FIXED, COMPOSITIOIN, 4.7K ±10%, ½W	ALL
R-403	31187-1	RESISTOR, TEMPERATURE, SENSITIVE, 0.24 ohm ±10%, +T.C.	A, C
R-403	31179-1	RESISTOR, TEMPERATURE, SENSITIVE, 0.47 ohm ±10%, +T.C.	B, D
R-404	31141-471	RESISTOR, FIXED,COMPOSITION, 470 ohm ±10%, ½W	ALL
R-405	31141-689	RESISTOR, FIXED, COMPOSITION, 6.8 ohm ±10%, ½W	A, C
R-405	31141-829	RESISTOR, FIXED, COMPOSITION, 8.2 ohm ±10%, ½W	B, D
R-406	31136-103	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 2W	ALL
R-408	31141-822	RESISTOR, FIXED, COMPOSITION, 8.2K ±10%, ½W	A, B
R-408	31141-471	RESISTOR, FIXED, COMPOSITION, 470 ohm ±10%, ½W	C, D
R-409	31175-11	RESISTOR, WIREWOUND, 75 ohm ±5%, 5W	B, D
R-410	32045-13	RESISTOR, VARIABLE, Wirewound, 200 ohm, 2W	ALL
R-411	32045-13	RESISTOR, VARIABLE, Wirewound, 200 ohm, 2W	ALL
R-412	31175-22	RESISTOR, WIREWOUND, 1K ohm ±10%, 5W	ALL
R-413	31141-332	RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, ½W	C, D
R-414	31141-220	RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, ½W	C, D
R-415	31141-100	RESISTOR, FIXED, COMPOSITION, 10 ohm ±10%, ½W	A, C
R-415	31141-180	RESISTOR, FIXED, COMPOSITION, 18 ohm ±10%, ½W	B, D
R-416	31141-102	RESISTOR, FIXED, COMPOSITION, 1K ±10%, ½W	A, C
R-416	31141-331	RESISTOR, FIXED, COMPOSITION, 330 ohm ±10%, ½W	B, D
R-417	33002-109	RESISTOR, WIRE ADJUSTABLE, 1 ohm, 10W	A, C
R-417	33002-309	RESISTOR, WIRE ADJUSTABLE, 3 ohm, 10W	B, D
R-418	31141-102	RESISTOR, FIXED, COMPOSITION, 1K ±10%, ½W	ALL
R-501	31136-471	RESISTOR, FIXED, COMPOSITION, 470 ohm ±10%, 2W	ALL
R-502	31175-24	RESISTOR, WIREWOUND, 10 ohm ±10%, 7W	A, C
R-502	31136-220	RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, 2W	B, D
R-503	31141-229	RESISTOR, FIXED, COMPOSITION, 2.2 ohm ±10%, ½W	A, C
R-505	31135-274	RESISTOR, FIXED, COMPOSITION, 270K ±10%, 1W	ALL
R-506	31136-101	RESISTOR, FIXED, COMPOSITION, 100 ohm ±10%, 2W	ALL
R-507	31175-11	RESISTOR, WIREWOUND, 75 ohm ±5%, 5W	B
R-511	31157-6	RESISTOR, WIREWOUND, 42 ohm ±5%, 7W	D
T-401	11706-2	TRANSFORMER, AUDIO, Transistor Driver	ALL
T-402	11704-2	TRANSFORMER, AUDIO, OUTPUT, 14 Volt	A, C
T-402	11705-2	TRANSFORMER, AUDIO OUTPUT, 28 Volt	B, D
T-501	11697-1	TRANSFORMER, POWER, 14 Volt	A, C
T-501	11698-1	TRANSFORMER, POWER, 28 Volt	B, D



T(12) MP-12A-1
Parts Location Drawing



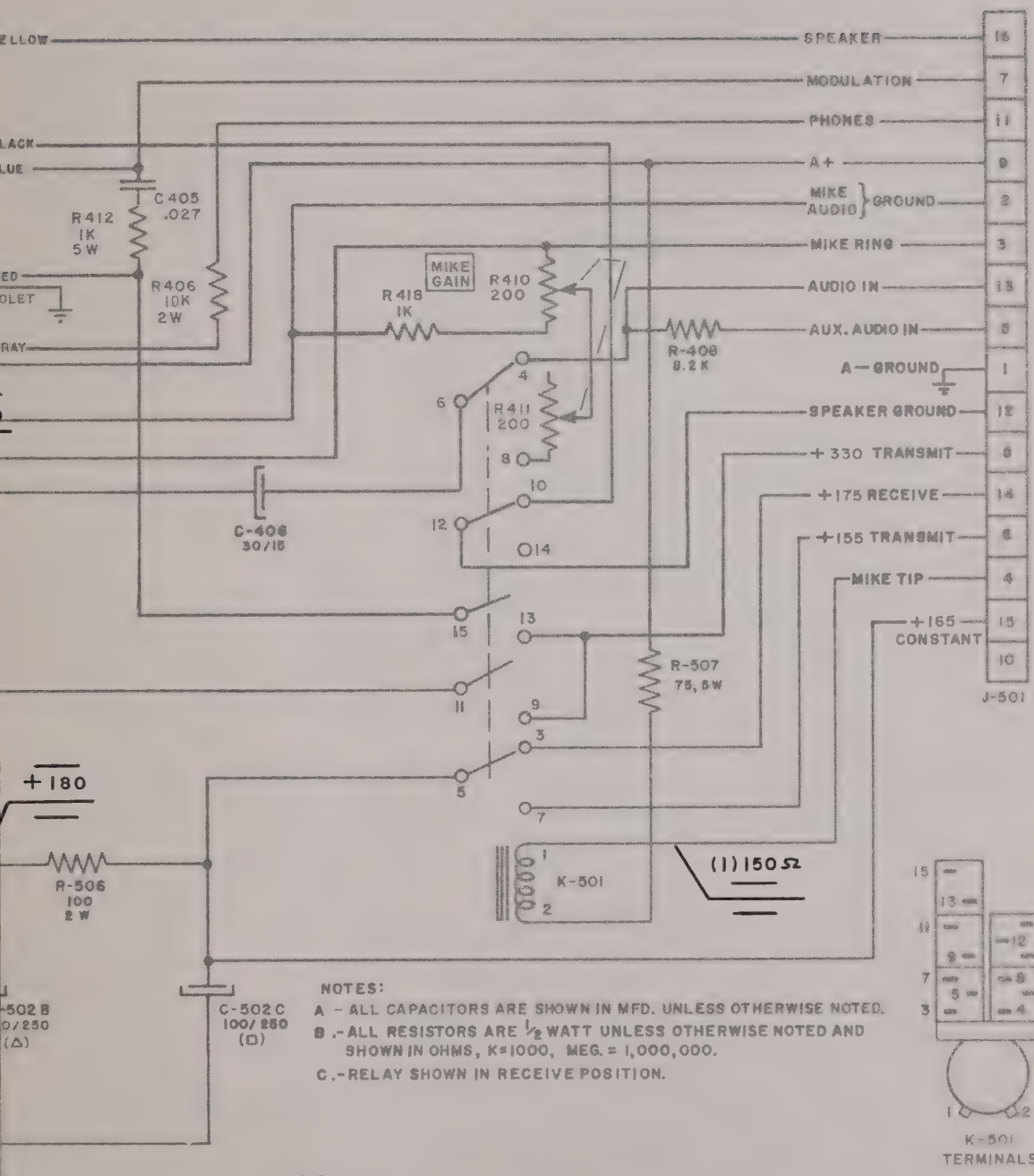
TEST DATA NOTES:
1. MEASURED WITH RESPECT TO A+, PIN 9.
2. MEASURED WITH RESPECT TO RED/WHITE LEAD OF T-501.
3 MEASURED WITH RESPECT TO CHASSIS GROUND.

TEST DATA
DC RESISTANCE
DC VOLTAGE & POLARITY
AC VOLTAGE OR WAVESHAPE & P-P VOLTAGE

NOTES:
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.- ALL RESISTORS ARE ½ WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.
C.- RELAY SHOWN IN RECEIVE POSITION.

NOTES:
1. RESISTANCE READINGS MEASURED WITH CABLE CONNECTOR REMOVED FROM J-501.
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 13.75 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000 Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE VTVM OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

Figure 6-1 MODULATOR-POWER UNIT, T(12) MP-12A-1
(Drawing and Schematic)



T DATA

ESISTANCE

OLTAGE & POLARITY

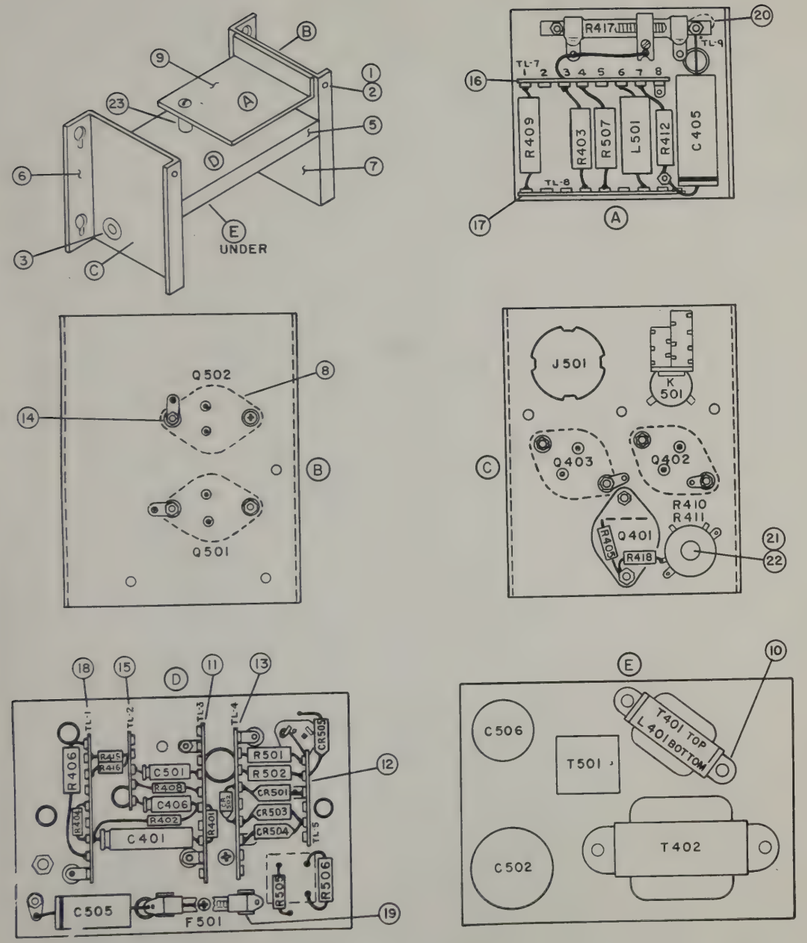
OLTAGE OR

SHAPE & P-P VOLTAGE

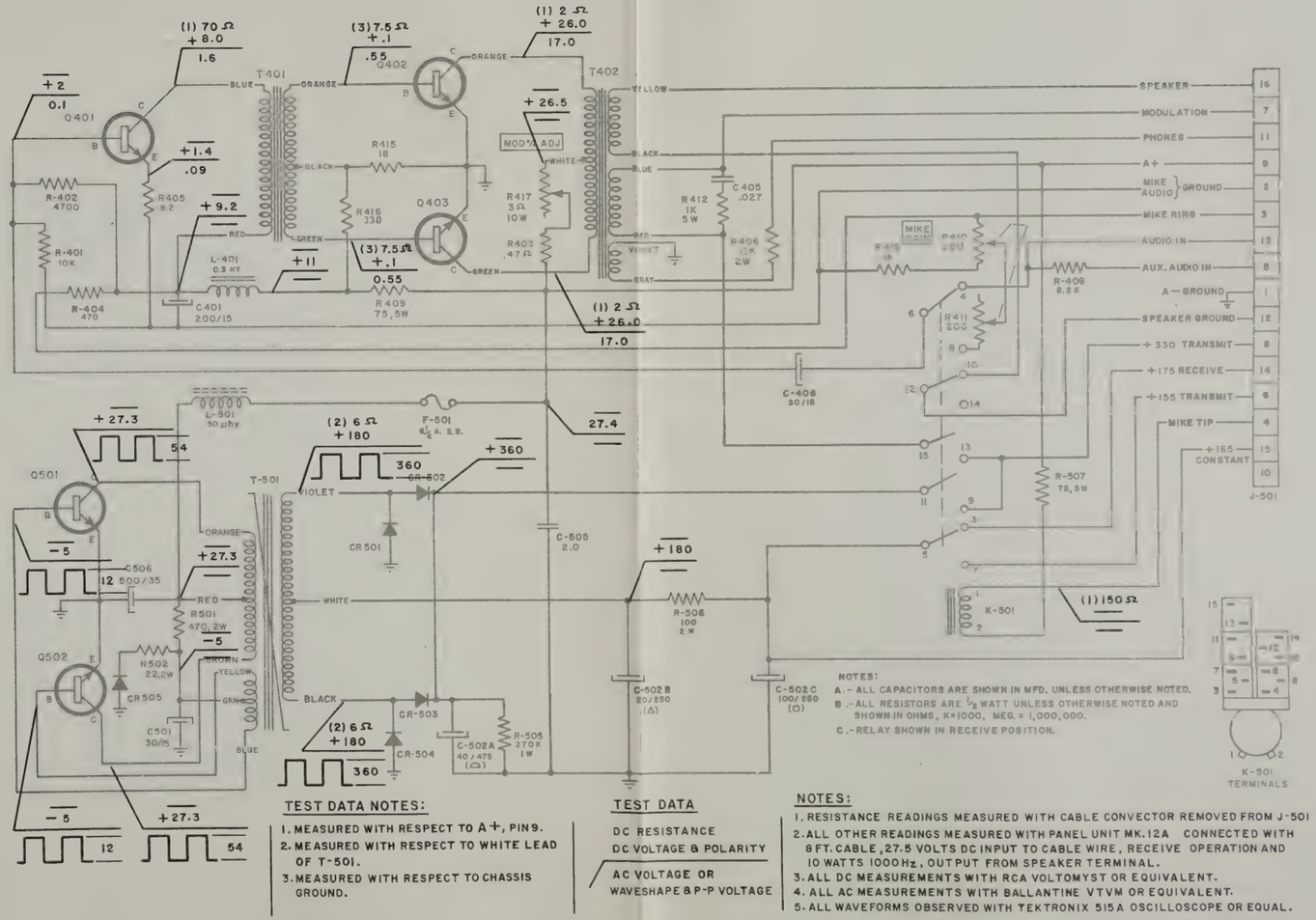
NOTES:

1. RESISTANCE READINGS MEASURED WITH CABLE CONVECTOR REMOVED FROM J-501
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 27.5 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE VTVM OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

Figure 6-2 MODULATOR-POWER UNIT, T(24) MP-12A-1 (Drawing and Schematic)



T(24) MP-12A-1
Parts Location Drawing



TEST DATA NOTES:

1. MEASURED WITH RESPECT TO A+, PIN 9.
2. MEASURED WITH RESPECT TO WHITE LEAD OF T-501.
3. MEASURED WITH RESPECT TO CHASSIS GROUND.

TEST DATA

DC RESISTANCE
DC VOLTAGE & POLARITY
AC VOLTAGE OR WAVESHAPE & P-P VOLTAGE

NOTES:

1. RESISTANCE READINGS MEASURED WITH CABLE CONVECTOR REMOVED FROM J-501
2. ALL OTHER READINGS MEASURED WITH PANEL UNIT MK.12A CONNECTED WITH 8 FT. CABLE, 27.5 VOLTS DC INPUT TO CABLE WIRE, RECEIVE OPERATION AND 10 WATTS 1000Hz, OUTPUT FROM SPEAKER TERMINAL.
3. ALL DC MEASUREMENTS WITH RCA VOLTOMYST OR EQUIVALENT.
4. ALL AC MEASUREMENTS WITH BALLANTINE VTVM OR EQUIVALENT.
5. ALL WAVEFORMS OBSERVED WITH TEKTRONIX 515A OSCILLOSCOPE OR EQUAL.

NOTES:
A. - ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B. - ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG. = 1,000,000.
C. - RELAY SHOWN IN RECEIVE POSITION.

Figure 6-2 MODULATOR-POWER UNIT, T(24) MP-12A-1
(Drawing and Schematic)

TEST POINTS

See Fig. 6-1 for test points and values.

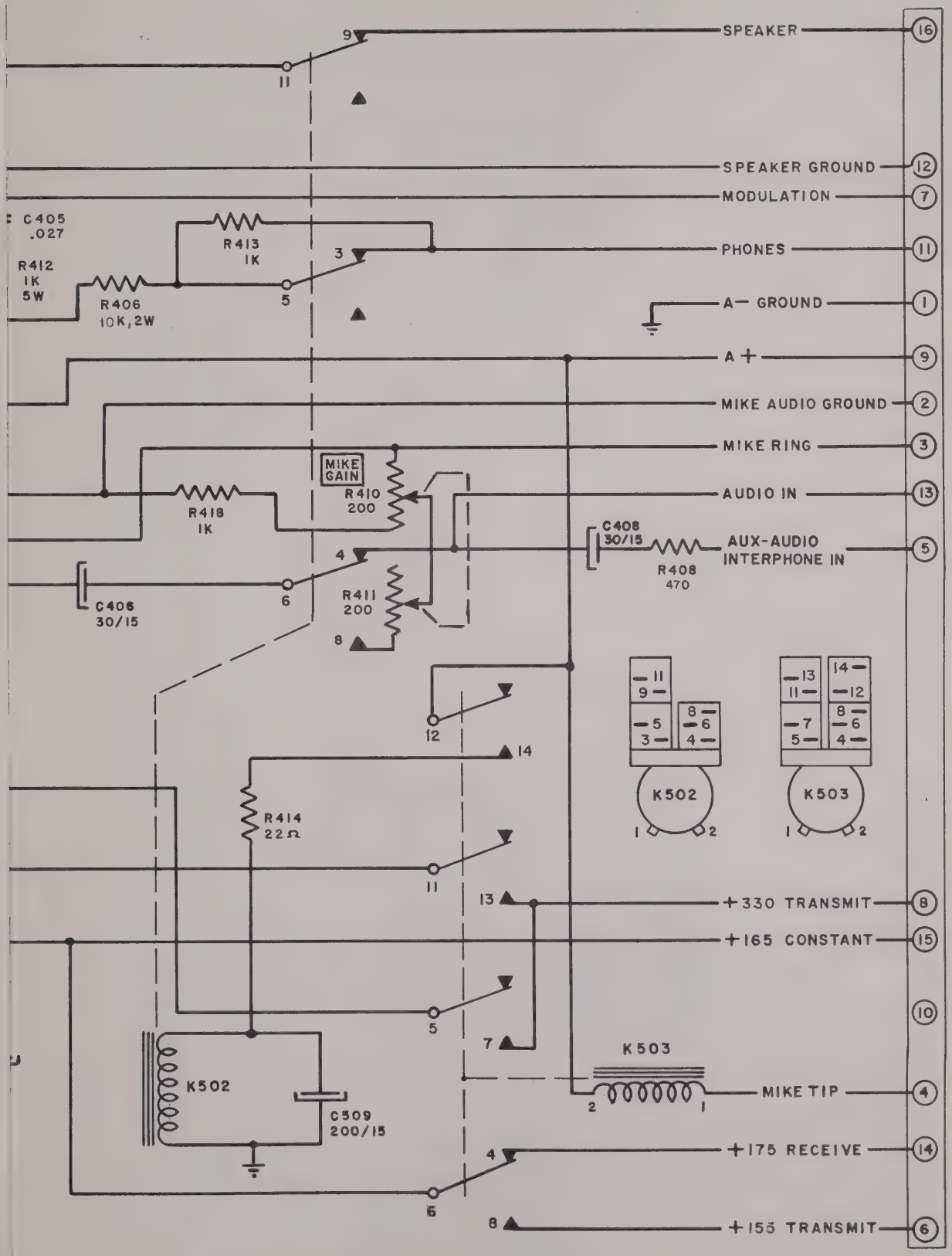
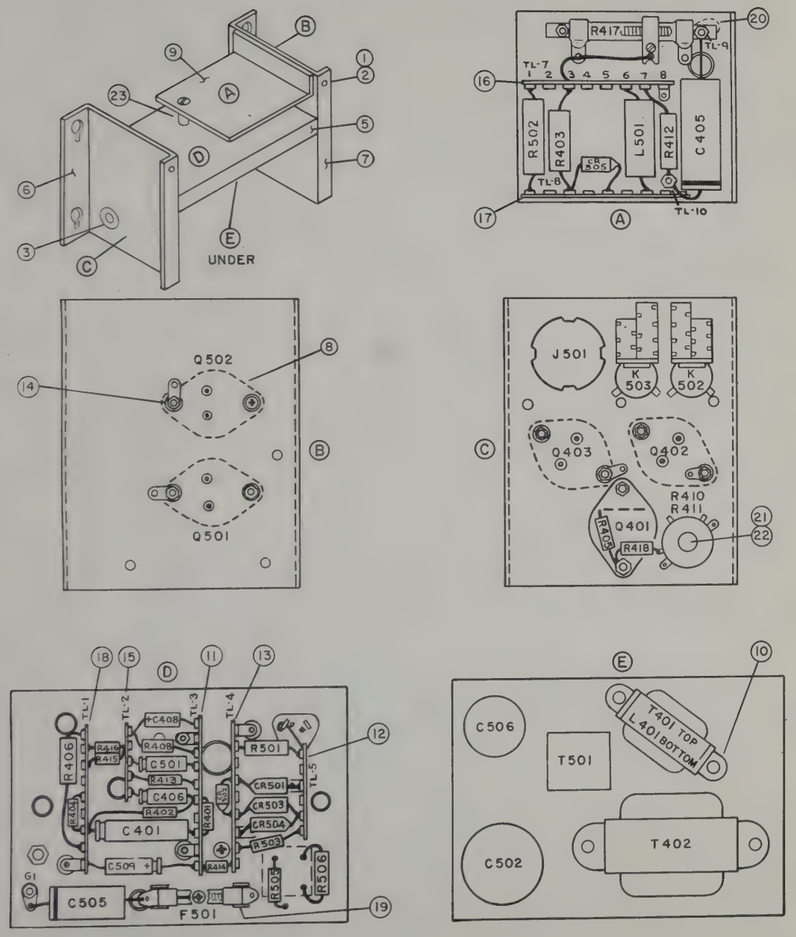


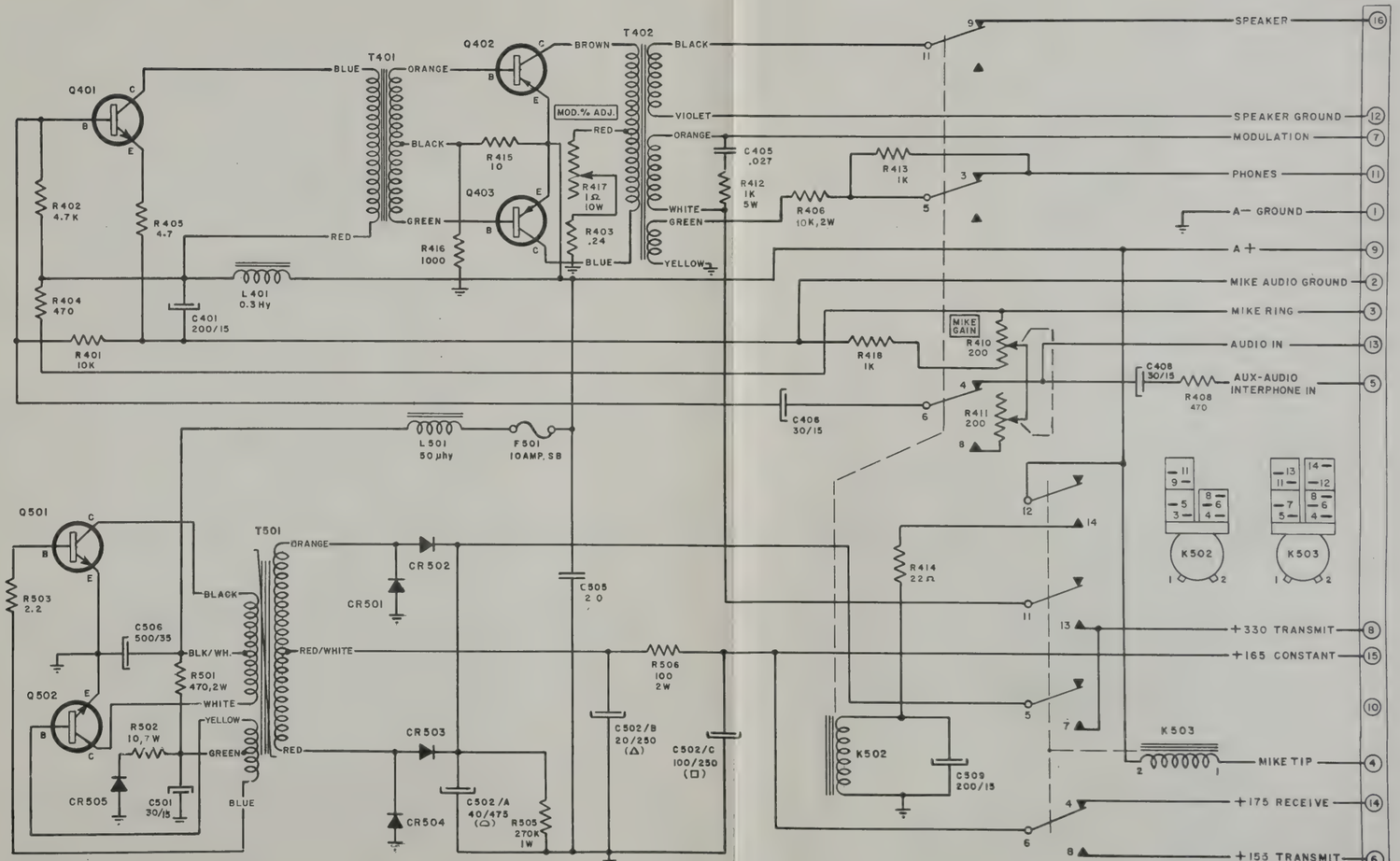
Figure 6-3 MODULATOR-POWER UNIT, T(12) MP-12AH-1 (Drawing and Schematic)

TEST POINTS

See Fig. 6-1 for test points and values.



T(12) MP-12AH-1
Parts Location Drawing



NOTES:
A— ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B— ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS,
K = 1000 MEG = 1,000,000
C— RELAYS SHOWN IN RECEIVE POSITION.

Figure 6-3 MODULATOR-POWER UNIT, T(12) MP-12AH-1
(Drawing and Schematic)

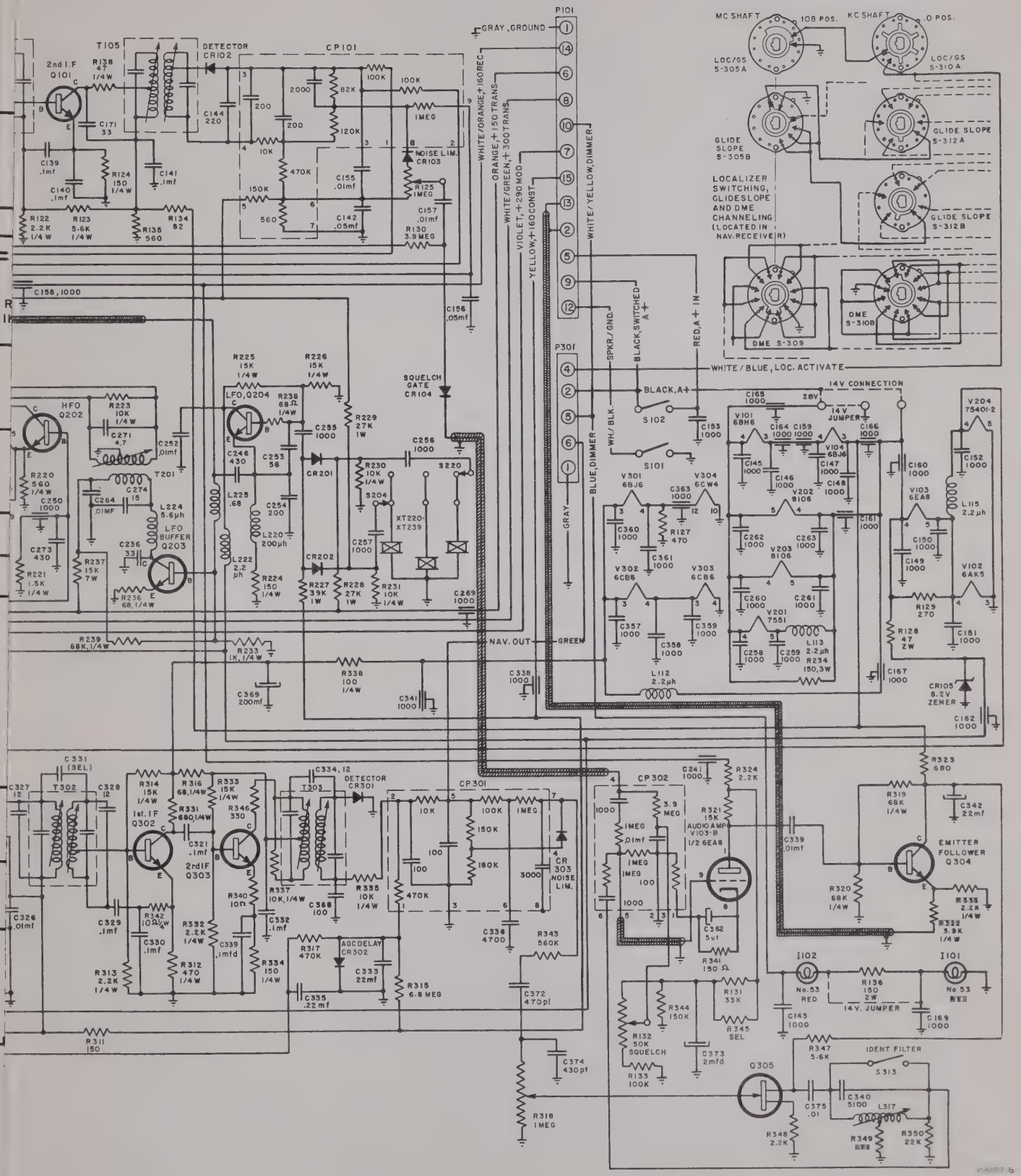


Figure 6-9 MARK 12B SCHEMATIC FOR CN195A

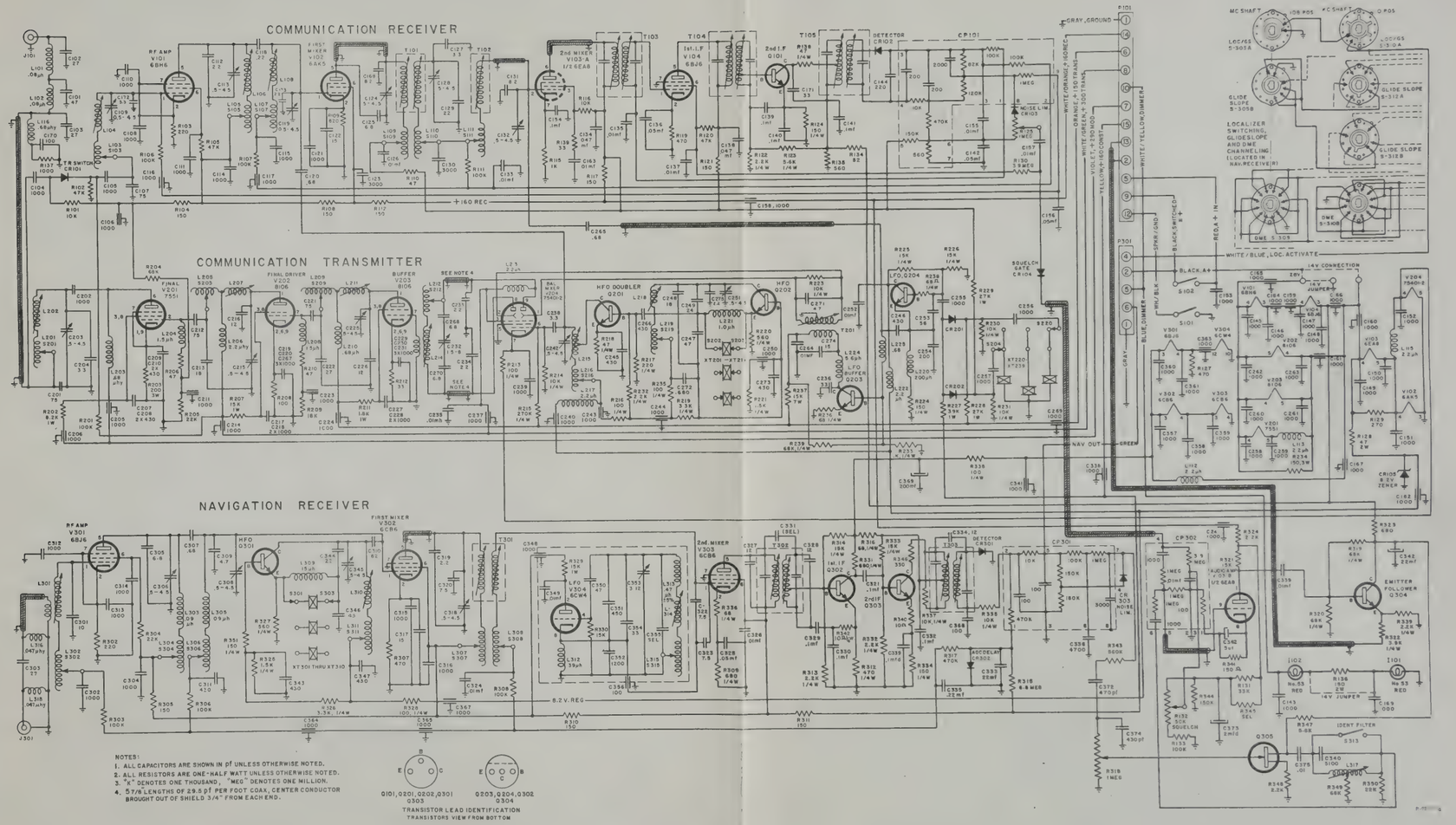

COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 57/8" LENGTHS OF 29.5 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

Figure 6-9 MARK 12B SCHEMATIC FOR CN195A

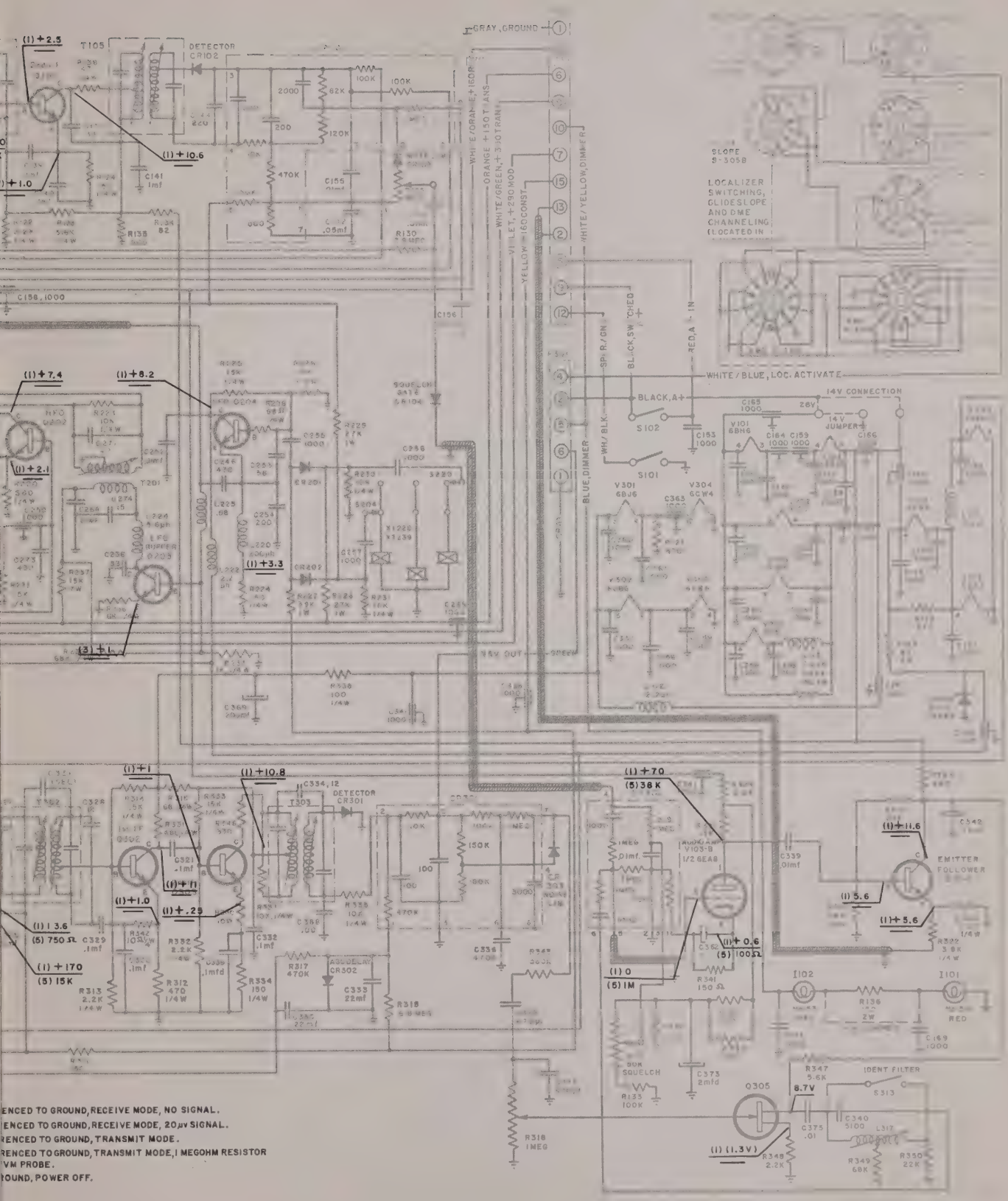
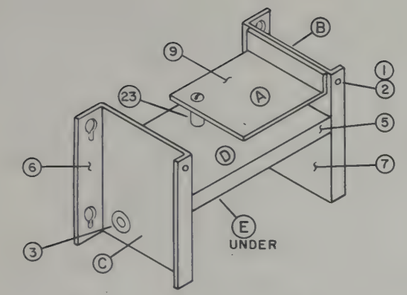


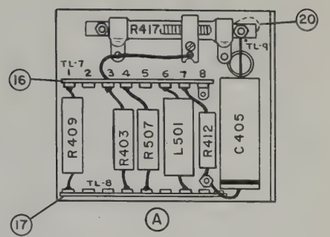
Figure 6-10 MARK 12B SCHEMATIC WITH TEST POINTS

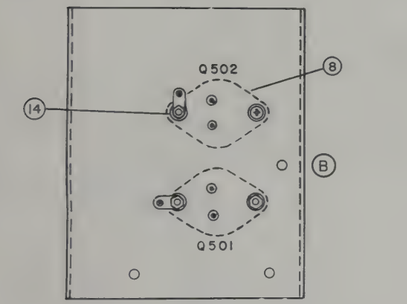
"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place.

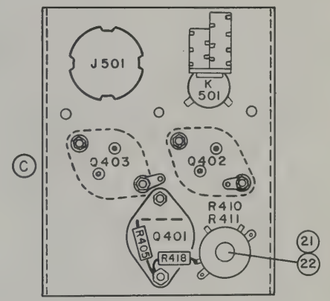
The Modulator-Power Unit identified as CNPB144C1 was modified by adding C510 and by changing the value of C505.

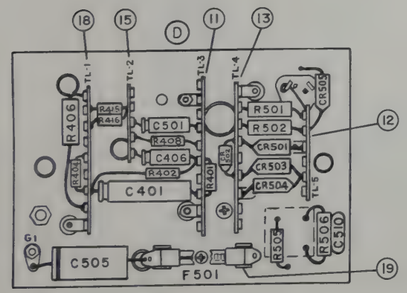
C505	21554-10	CAPACITOR, ELECTROLYTIC, 20 mfd, 35 v	CHANGED
C510	23094-183	CAPACITOR, MYLAR, .47 mfd, 200 v	ADDED

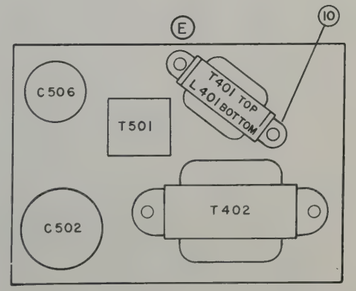












T(24)MP-12A-1 (CNPB144C1)

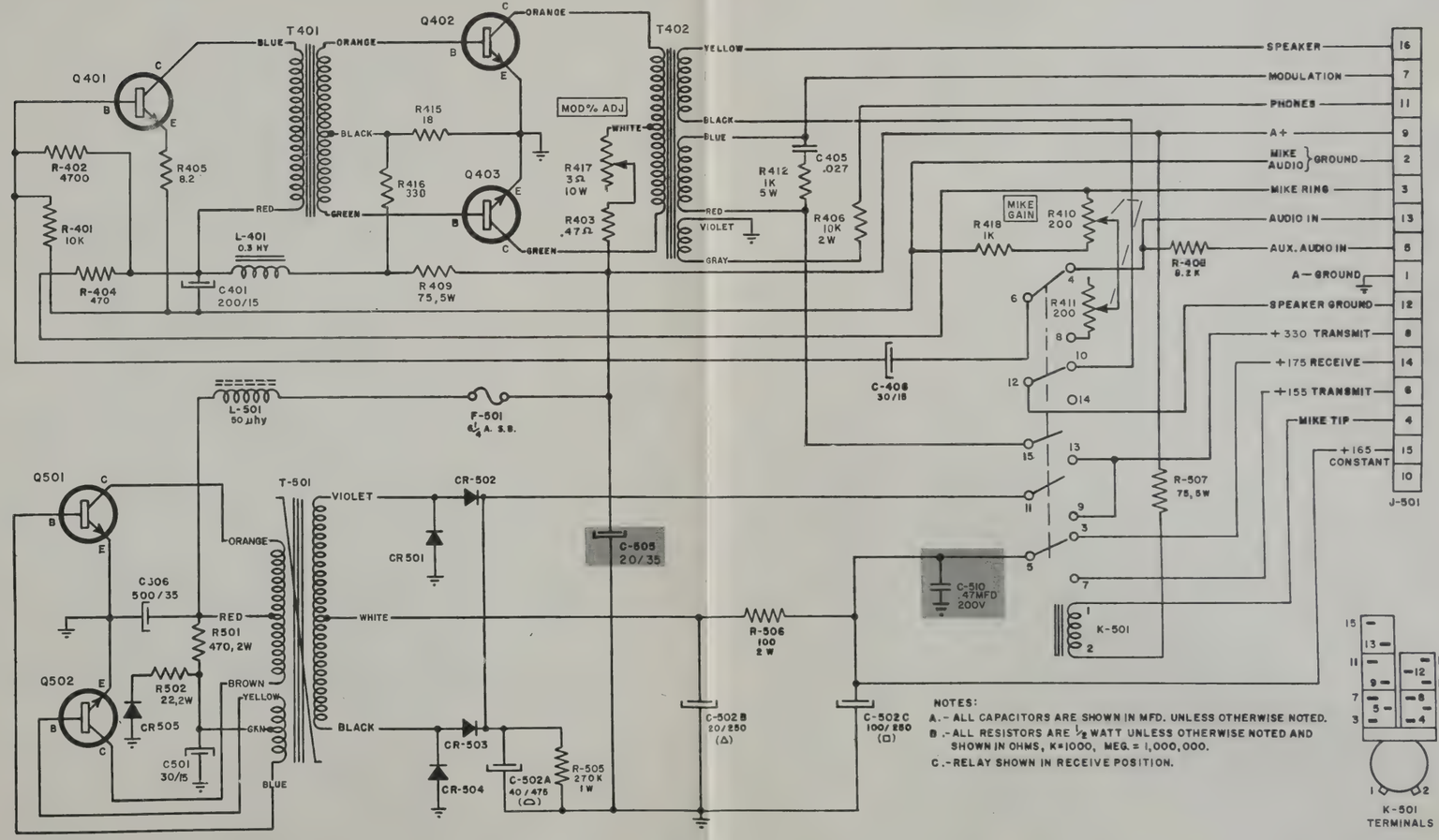
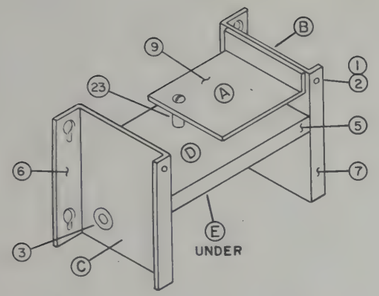


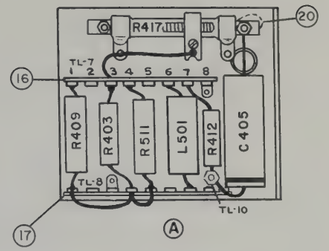
Figure 6-6 MODULATOR-POWER UNIT, T(24)MP-12A-1 (CNPB144C1) (Drawing and Schematic)

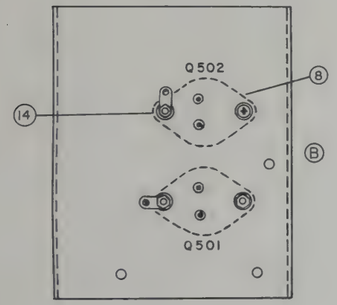
"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place.

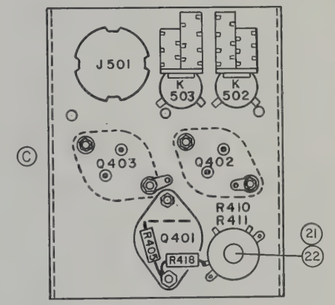
The Modulator-Power Unit identified as CNPB144C1 was modified by adding C510 and by changing the value of C505.

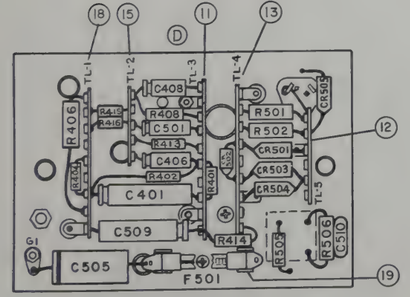
C505	21554-10	CAPACITOR, ELECTROLYTIC, 20 mfd. 35 v	CHANGED
C510	23094-183	CAPACITOR, MYLAR, .47 mfd, 200 v	ADDED

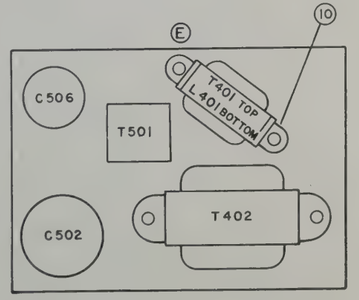




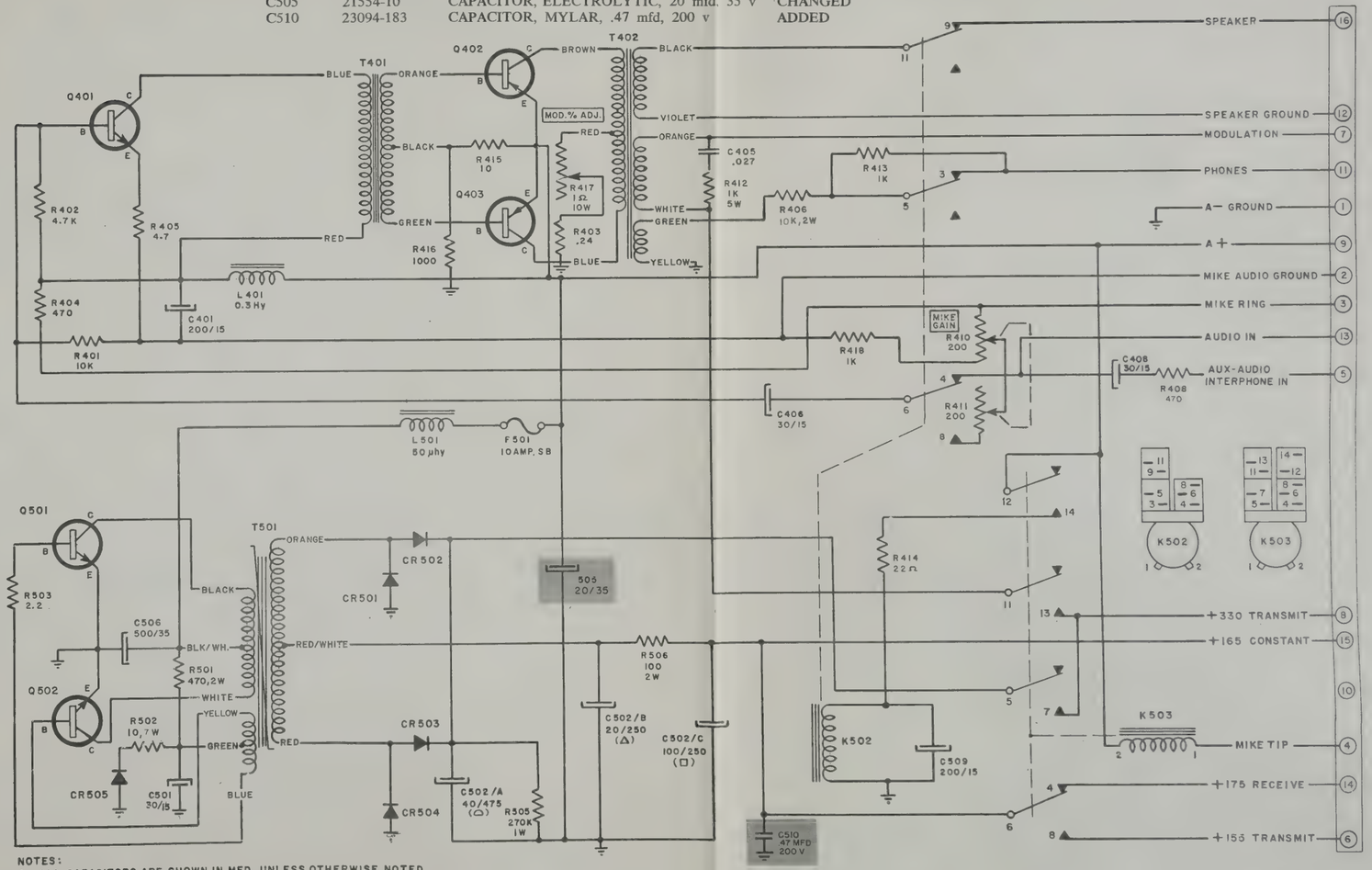








T(12)MP-12AH-1
Parts Location Drawing



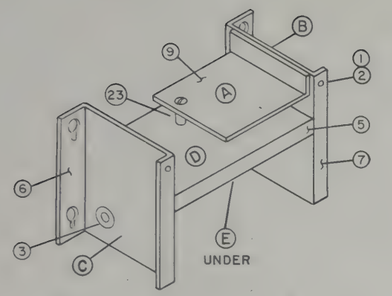
NOTES:
A– ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B– ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS.
K = 1000 MEG = 1,000,000
C– RELAYS SHOWN IN RECEIVE POSITION.

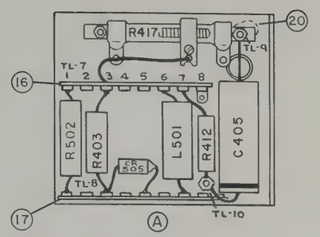
Figure 6-7 MODULATOR-POWER UNIT, T(12)MP-12AH-1 (CNPB144C1)
(Drawing and Schematic)

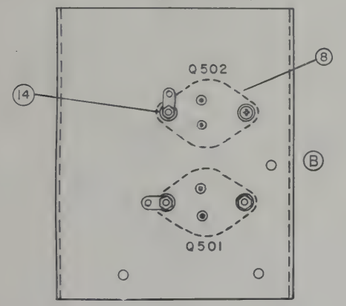
"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place.

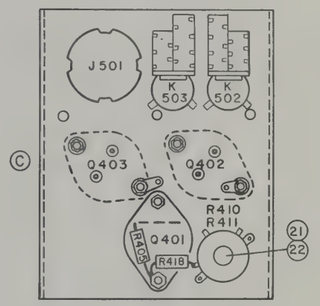
The Modulator-Power Unit identified as CNPB144C1 was modified by adding C510 and by changing the value of C505.

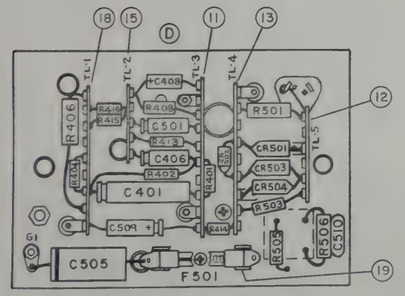
C505	21554-10	CAPACITOR, ELECTROLYTIC, 20 mfd, 35 v	CHANGED
C510	23094-183	CAPACITOR, MYLAR, .47 mfd, 200 v	ADDED

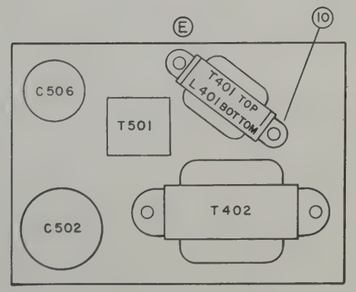




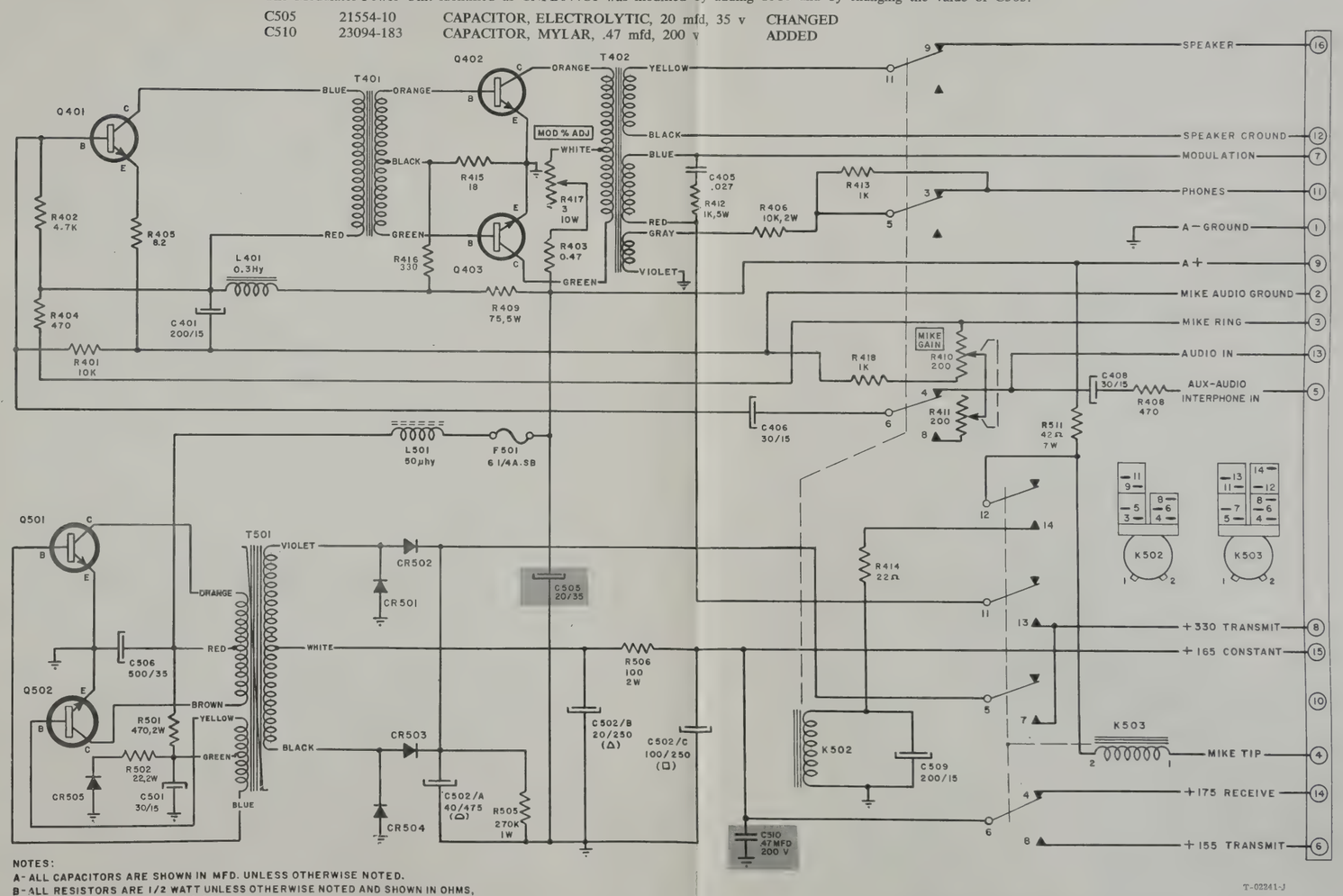








T(24)MP-12AH-1 (CNPB144C1)



NOTES:
A- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B- ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K = 1000, MEG = 1,000,000.
C- RELAYS SHOWN IN RECEIVE POSITION.

T-02241-J

Figure 6-8 MODULATOR-POWER UNIT, T(24)MP-12AH-1 (CNPB144C1) (Drawing and Schematic)

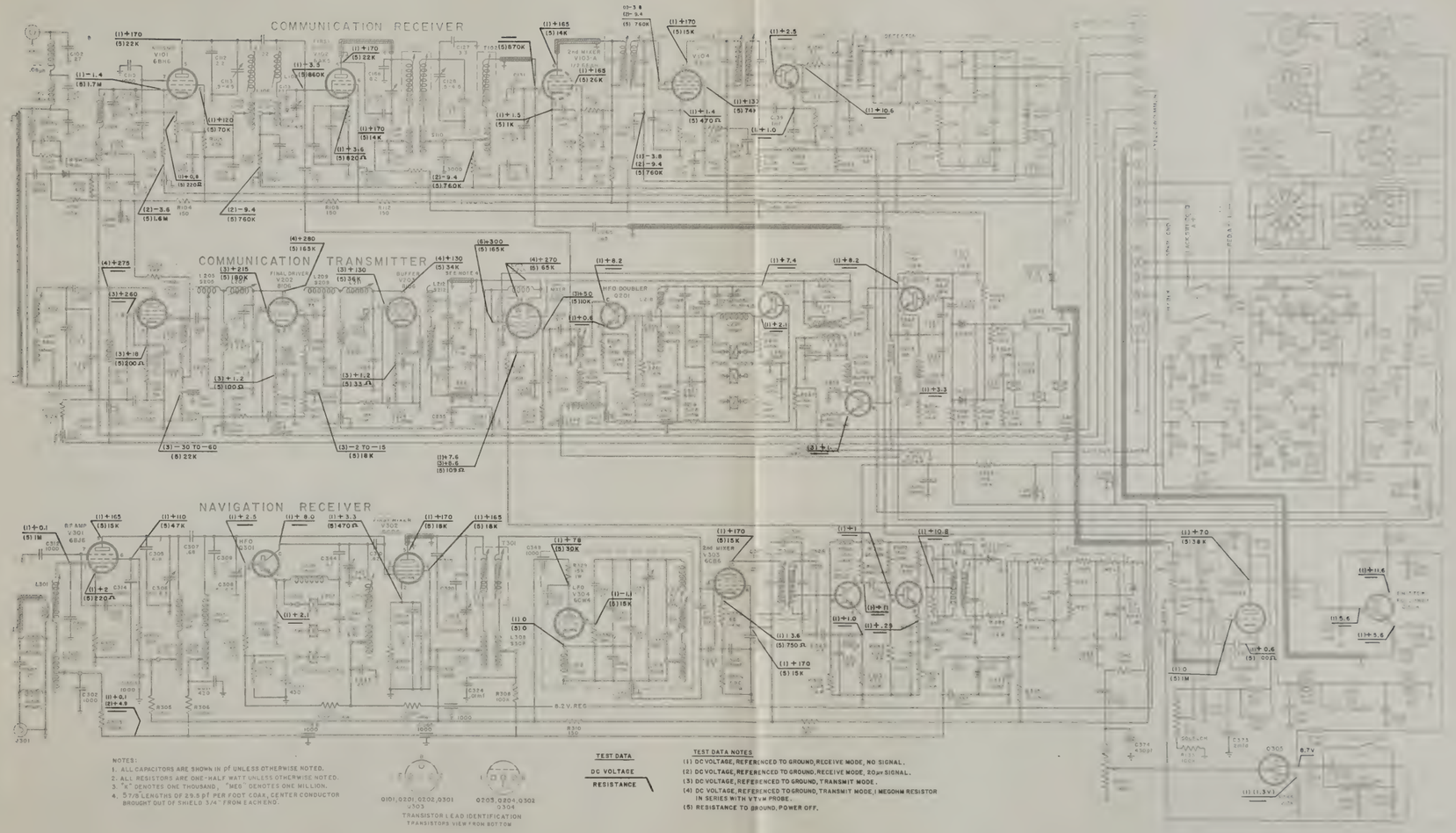

COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 57/8 LENGTHS OF 29.5 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM
TEST DATA
DC VOLTAGE
RESISTANCE
TEST DATA NOTES
(1) DC VOLTAGE, REFERENCED TO GROUND, RECEIVE MODE, NO SIGNAL.
(2) DC VOLTAGE, REFERENCED TO GROUND, RECEIVE MODE, 20 μv SIGNAL.
(3) DC VOLTAGE, REFERENCED TO GROUND, TRANSMIT MODE.
(4) DC VOLTAGE, REFERENCED TO GROUND, TRANSMIT MODE, 1 MEGOHM RESISTOR IN SERIES WITH VTVM PROBE.
(5) RESISTANCE TO GROUND, POWER OFF.

Figure 6-10 MARK 12B SCHEMATIC WITH TEST POINTS

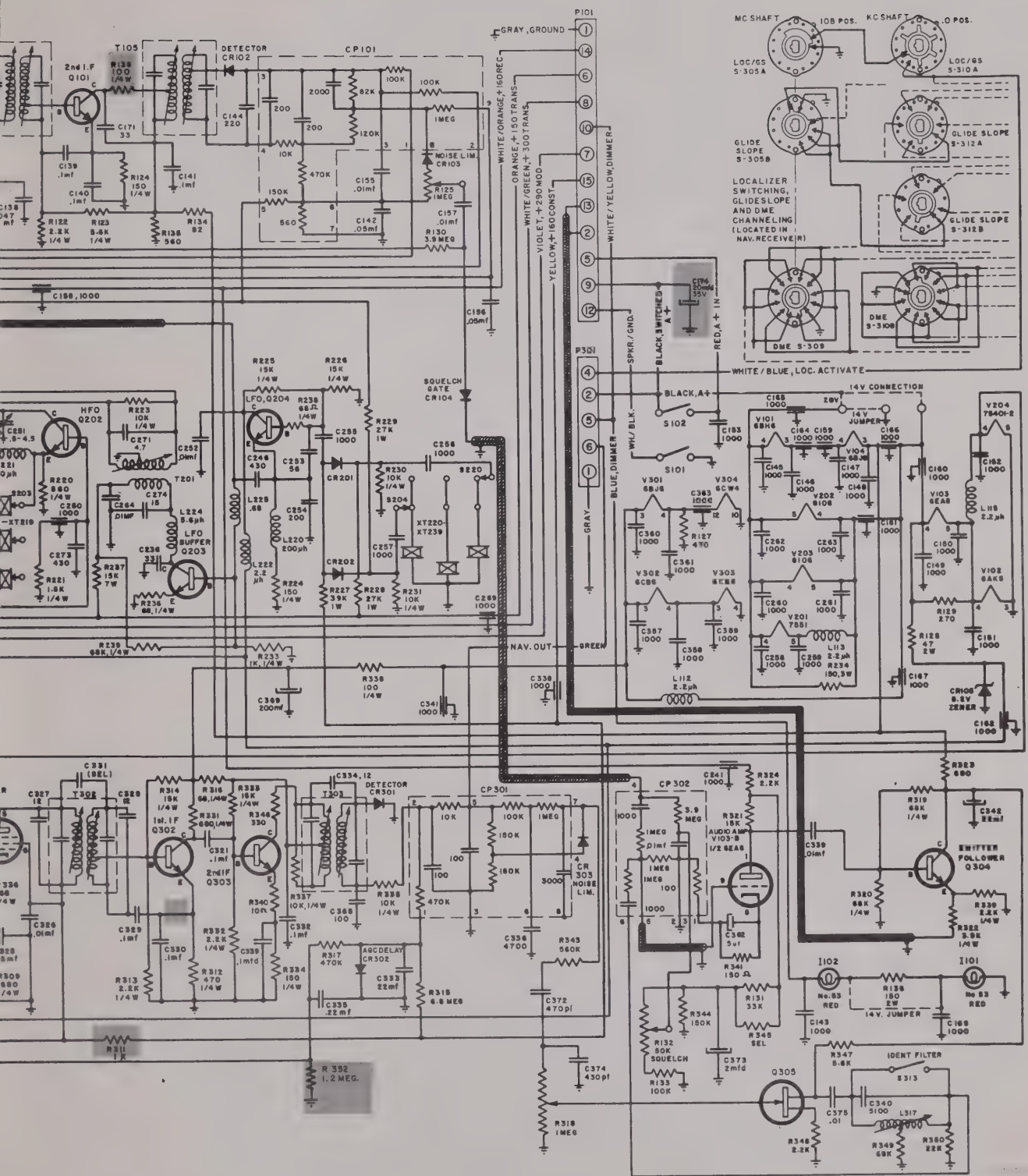


Figure 6-11 MARK 12B SCHEMATIC FOR CN195B

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place.

This schematic is provided for units of the Mark 12B which are designated as CN195B.

These units were modified to improve various circuits.

C174	21554-10	CAPACITOR, ELECTROLYTIC, 20 mfd, 35 v	ADDED to improve filtering.
C366	21554-38	CAPACITOR, ELECTROLYTIC, 40 mfd, 200 v	ADDED to increase OMNI stability.
R138	31192-101	RESISTOR, CARBON, 100 ohm ±10%, ¼ w	CHANGED due to regeneration of COM IF.
R311	31141-102	RESISTOR, CARBON, 1K ±10%, ¼ w	CHANGED to increase OMNI stability.
R342	——	——	DELETED.
R352	31141-125	RESISTOR, CARBON, 1.2 meg ±10%, ½ w	ADDED to increase gain of NAV IF.

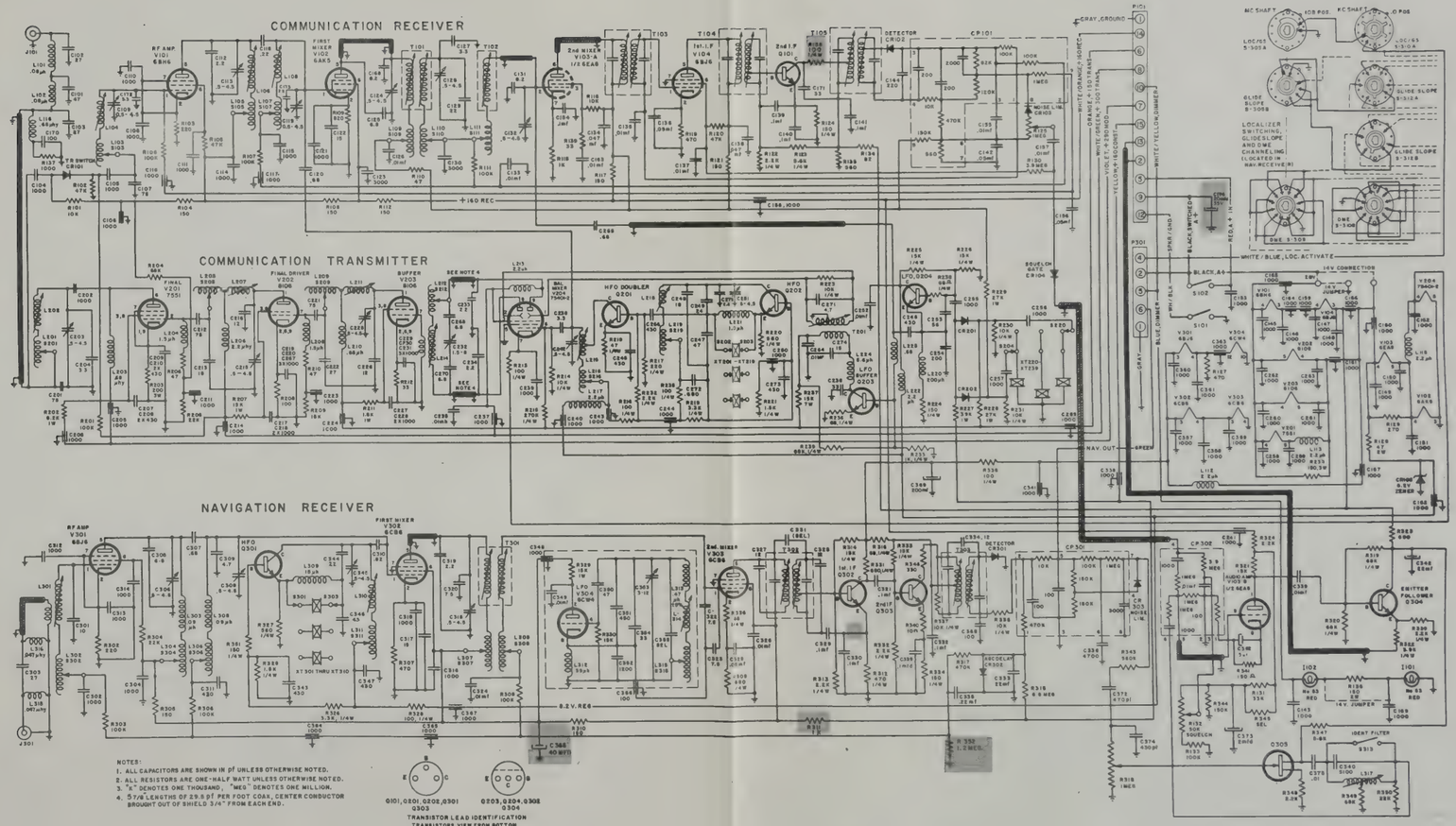

COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND. "MEG" DENOTES ONE MILLION.
4. 57/8 LENGTHS OF 29.5 pF PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
Q101, Q201, Q202, Q301 Q303
Q303, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

Figure 6-11 MARK 12B SCHEMATIC FOR CN195B

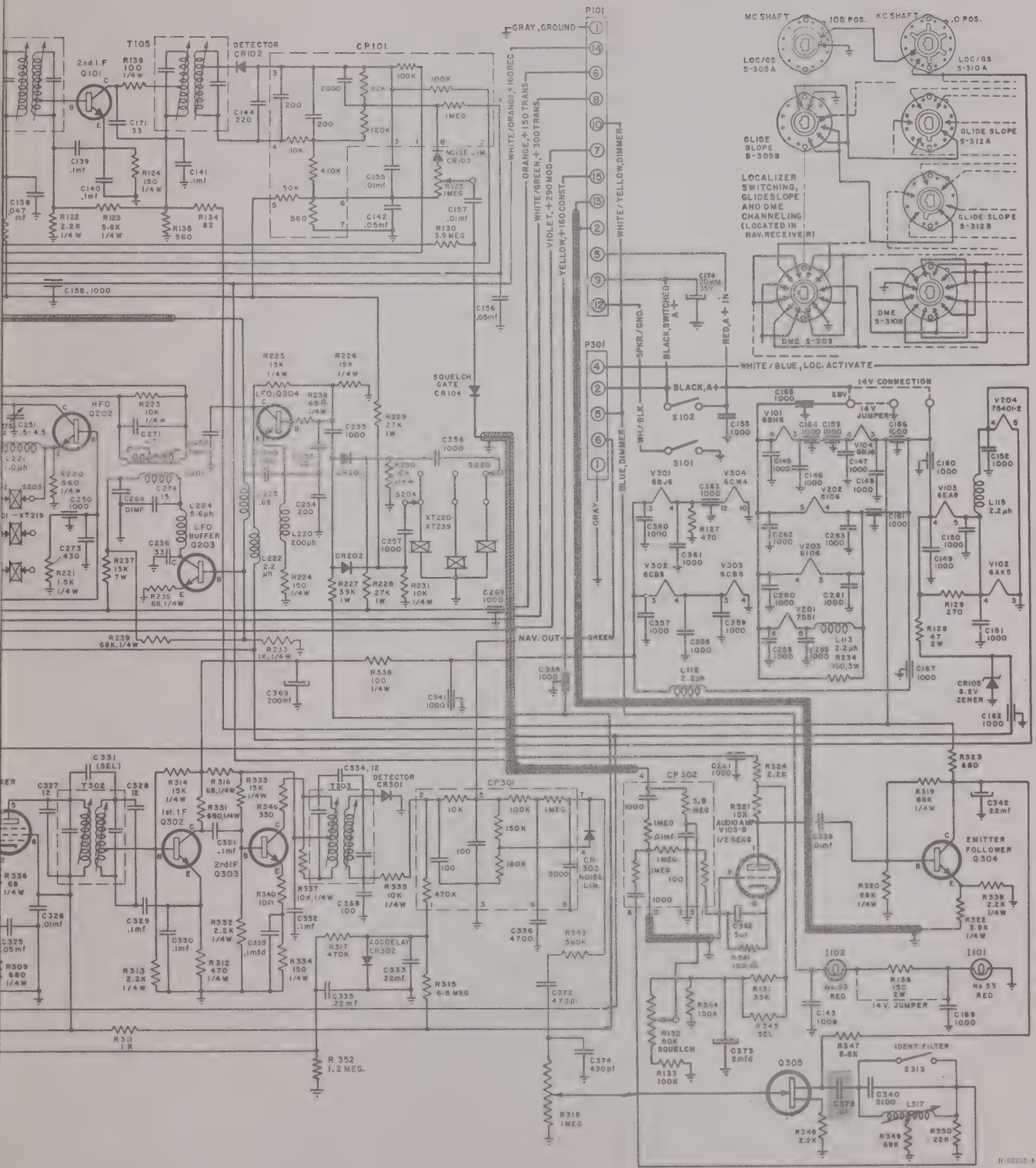


Figure 6-12 MARK 12B SCHEMATIC FOR CN195B1

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place.

This schematic is provided for units of the Mark 12B which are designated as CN195B1.

These units were modified to increase stability under high temperature.

C316	21291-6	CAPACITOR, CERAMIC DISC, .01 mfd, 500 v CHANGED (NAV stage)
C375	23089-63	CAPACITOR, MYLAR, INSULATED, .01 mfd ±10%, 80 v CHANGED (Audio)

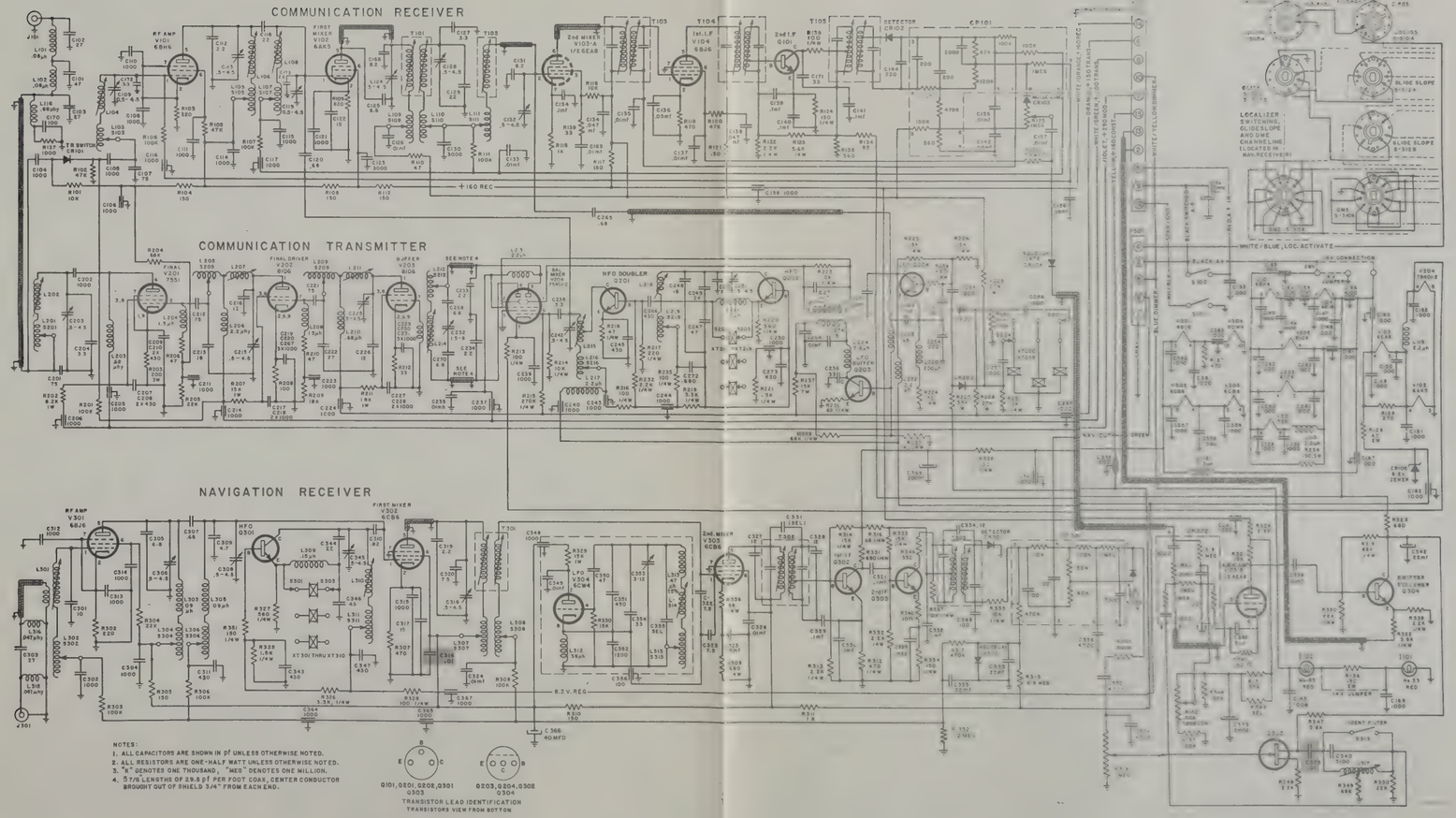

COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED.
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 5 7/8 LENGTHS OF 29.8 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

Figure 6-12 MARK 12B SCHEMATIC FOR CN195B1

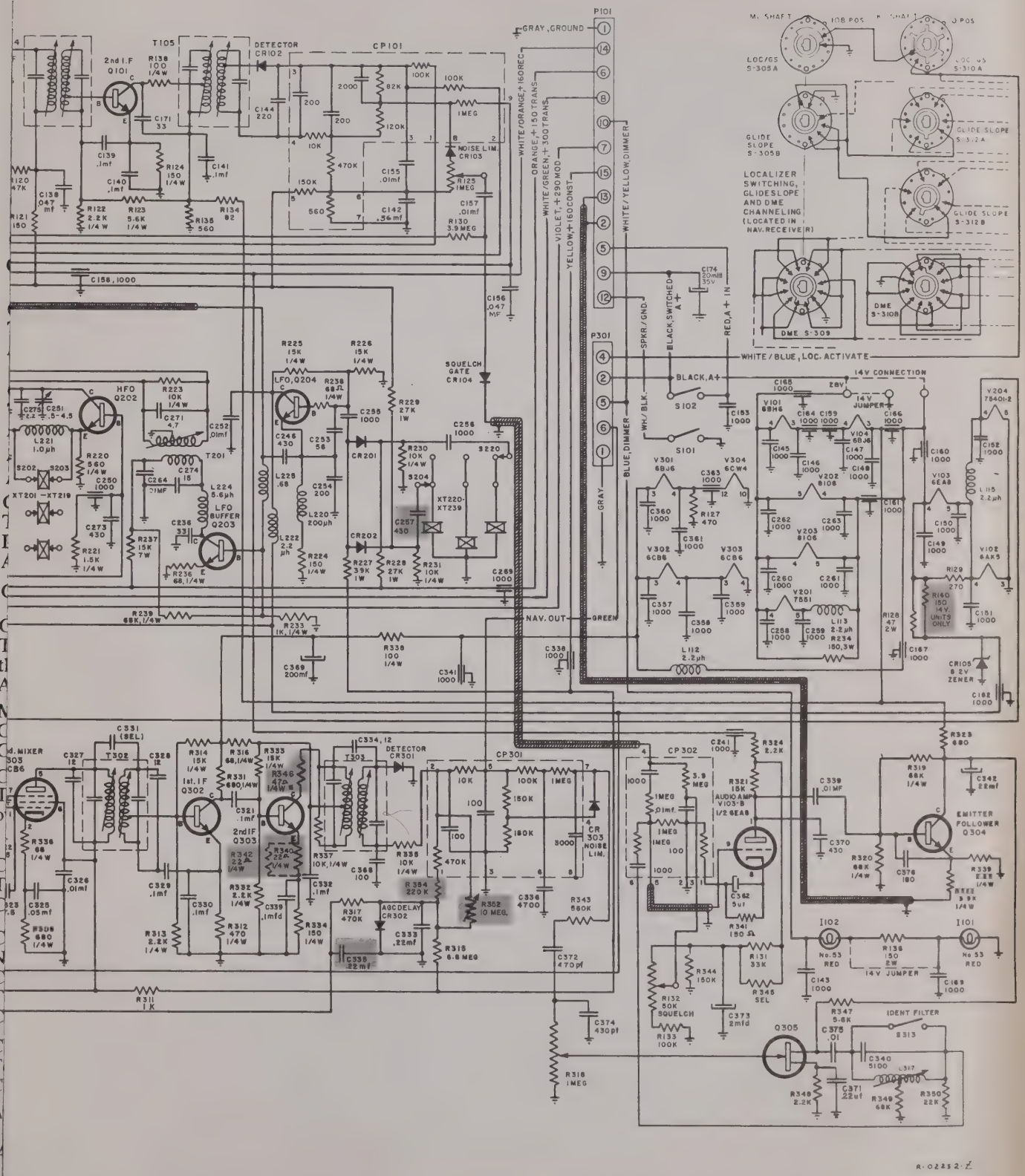


Figure 6-14 MARK 12B Schematic For Chassis CN195B6 thru B17

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

CN195B6
No electrical or mechanical component changes.

CN195B7
To raise frequency of NAV HFO to reduce bird problem the following were:
Changed R325 31192-821 RESISTOR, FIXED, COMPOSITION, 820 ±10%, ¼W
Changed R351 31192-820 RESISTOR, FIXED, COMPOSITION, 82 ±10%, ¼W

CN195B8
To prevent NAV HFO dropout under high temperature, the following were:
Changed R325 31192-102 RESISTOR, FIXED, COMPOSITION, 1K ±10%, ¼W
Changed C347 21291-23 CAPACITOR, CERAMIC DISC, .004mfd ±10%, 500 v
(Refer to Service Bulletin for MK12B, No. 3)

CN195B9
To stabilize NAV HFO supply voltage in 14v units only.
Added R140 31141-151 RESISTOR, FIXED, COMPOSITION, 150 ±10%, ½W
(Refer to Service Bulletin for MK12B, No. 1)

CN195B10
To stop transmitter spurs, the following were:
Added C176 24516-100 CAPACITOR, CERAMIC DISC, 10mmf ±1.0mmf, 500 v, NPO
Added C175 24515-9 CAPACITOR, CERAMIC DISC, .01mfd +80 -20%, 50 v
Added R113 31192-470 RESISTOR, FIXED, COMPOSITION, 47 ±10%, ¼W

CN195B11
To increase accuracy in setting Localizer voltage.
Deleted R353 and replaced by R352
Added R352 32064-2 RESISTOR, VARIABLE, CARBON, 10 Meg ±30%, ½W
Changed C335 23089-79 CAPACITOR, MYLAR INSUL, 22mfd ±10%, 80 v

CN195B12
To increase OMNI-Localizer detector output voltage and to extend range of R352, the following were:
Added R354 31192-224 RESISTOR, FIXED, COMPOSTION, 220K ±10%, ¼W

Mechanical changes:
Changed to: 61481-4 Shaft and Detent Assy to P/N
Changed to: 84157-1 Spring, Contact to P/N

CN195B13
To eliminate alternator whine pick-up in IDENT filter coil a shield was wrapped over the IDENT filter coil.
56628-1 Shield, Mu Metal

CN195B14
To improve performance, C257 was changed.
Changed C257 21291-25 CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V

CN195B15
No mechanical or electrical changes.

CN195B16
To increase Localizer output, R346 was changed.
Changed R346 31192-470 RESISTOR, FIXED, COMPOSITION, 47 ±10% ¼W (47 ohms is nominal value)

CN195B17
To increase stability in the NAV IF the following were:
Changed R340 31192-220 RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, ¼W
Added R342 31192-220 RESISTOR, FIXED, COMPOSITION, 22 ohm ±10%, ¼W

*Adjust on Page 5-9 data for Q203 and add Q204 entry which was never listed.

Q203 75550-7 TRANSISTOR, SILICON PLANAR
Q204 75550-7 TRANSISTOR, SILICON PLANAR

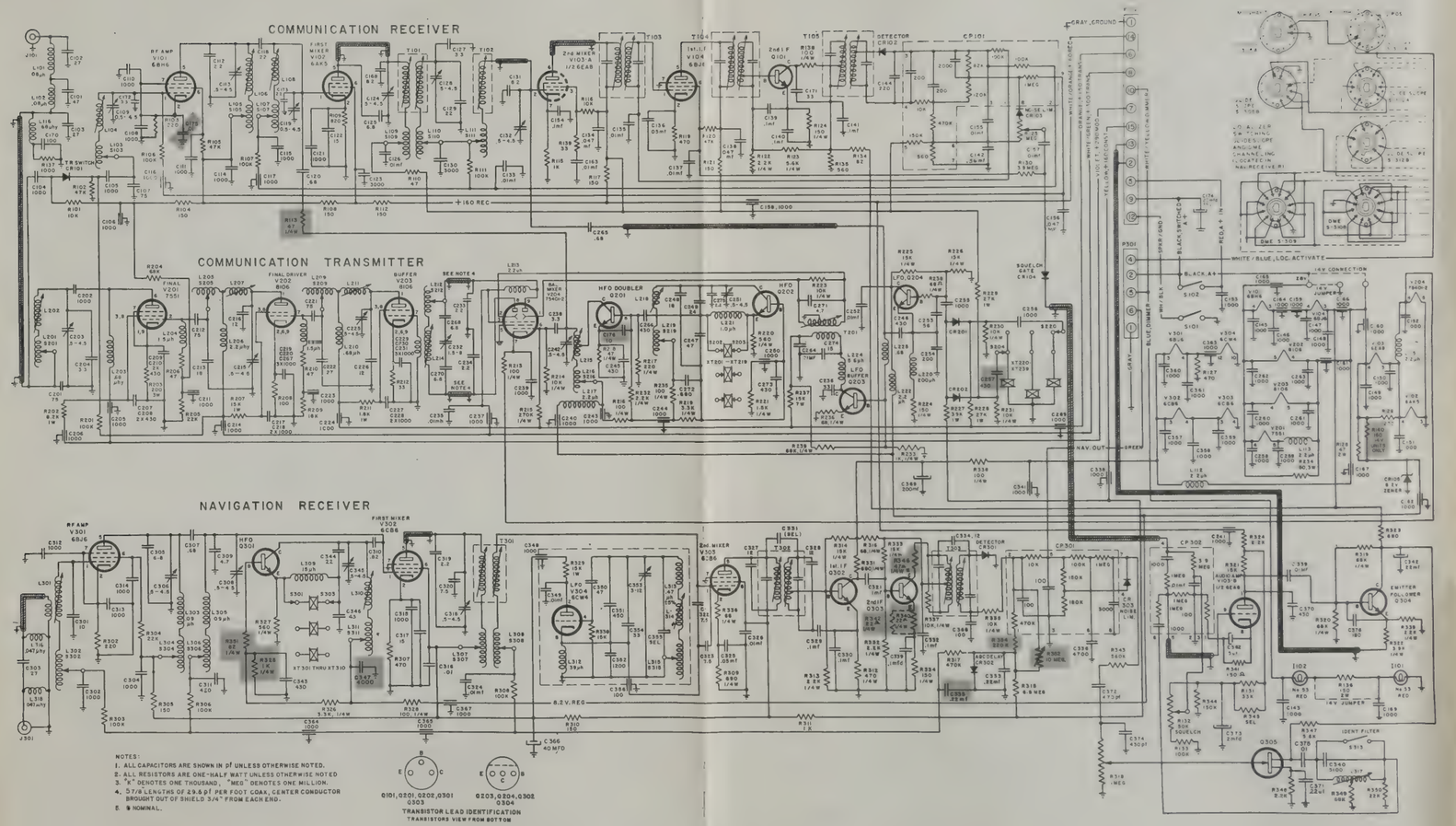

COMMUNICATION RECEIVER
COMMUNICATION TRANSMITTER
NAVIGATION RECEIVER
NOTES:
1. ALL CAPACITORS ARE SHOWN IN pf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE ONE-HALF WATT UNLESS OTHERWISE NOTED
3. "K" DENOTES ONE THOUSAND, "MEG" DENOTES ONE MILLION.
4. 5 7/8 LENGTHS OF 29.8 pf PER FOOT COAX, CENTER CONDUCTOR BROUGHT OUT OF SHIELD 3/4" FROM EACH END.
5. ✱ NOMINAL.
Q101, Q201, Q202, Q301 Q303
Q203, Q204, Q302 Q304
TRANSISTOR LEAD IDENTIFICATION
TRANSISTORS VIEW FROM BOTTOM

Figure 6-14 MARK 12B Schematic For Chassis CN195B6 thru B17

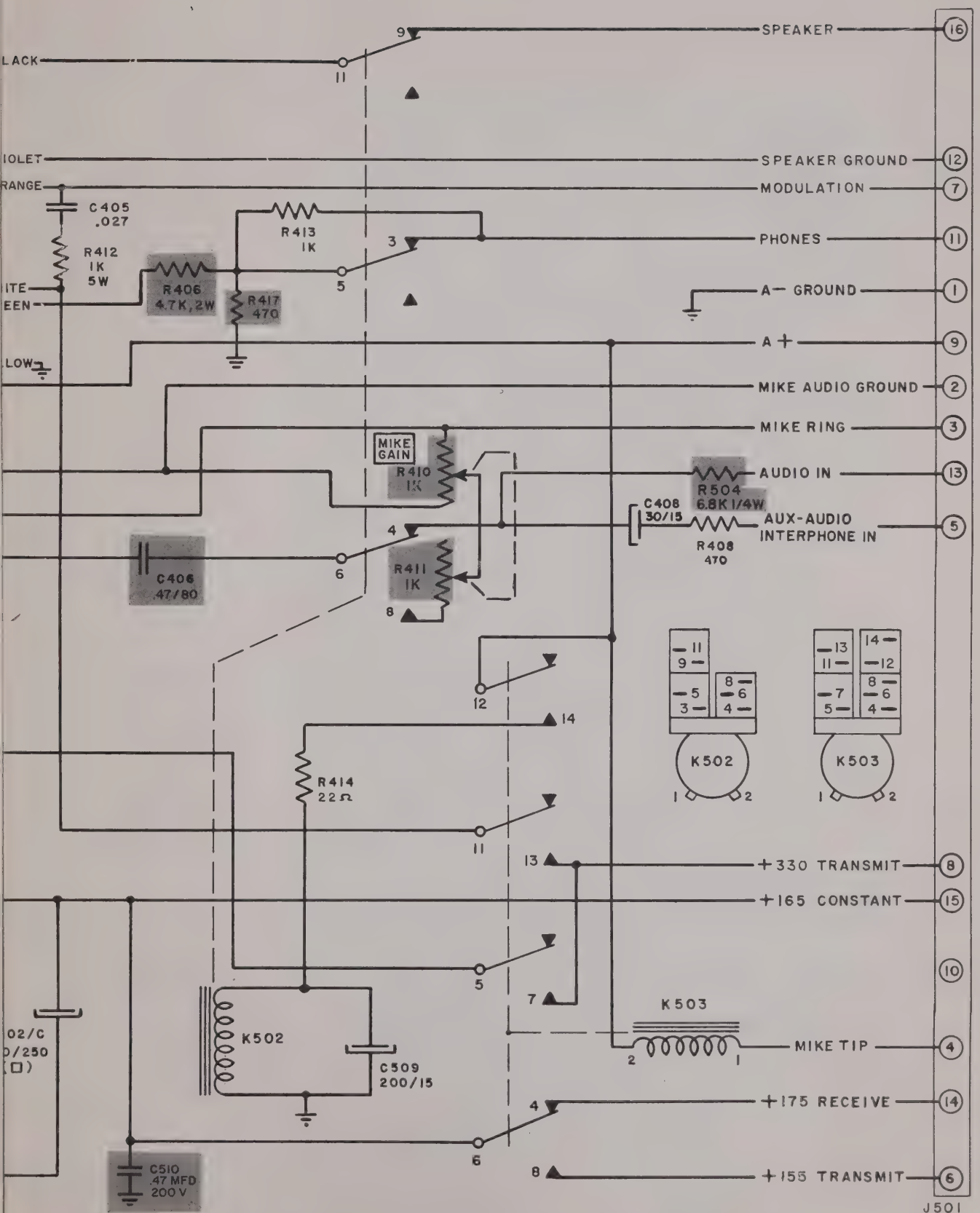


Figure 6-15 Modulator - Power Unit, T12 MP-12AH-1
(for chassis CNPB144-C2 thru C7)

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

T12 MP-12AH-1 /T-02240-U

CNPB144-C2

To lower conductor RF energy on 14V line, C505 was changed and C510 was added.

Changed	C505	21554-10	CAPACITOR, ELECTROLYTIC, 20mfd, 35 v
Added	C510	23094-183	CAPACITOR, MYLAR, .47mfd, 200 v

CNPB144-C3

To provide for increased mike gain adjustment range, R418 was removed, R410 and R411 were changed.

Deleted	R418		
Changed	R410	32045-5	RESISTOR, CARBON, 1K ±10%, ½W
Changed	R411	32045-5	RESISTOR, CARBON, 1K ±10%, ½W

CNPB144-C4

Q401 was changed and to improve audio response, C406 was changed.

Changed	Q401	75576-2	TRANSISTOR, SILICON, NPN
Changed	C406	23089-83	CAPACITOR, MYLAR, .47mfd ±10%, 80v

CNPB144-C5

Deleted R417

CNPB144-C6

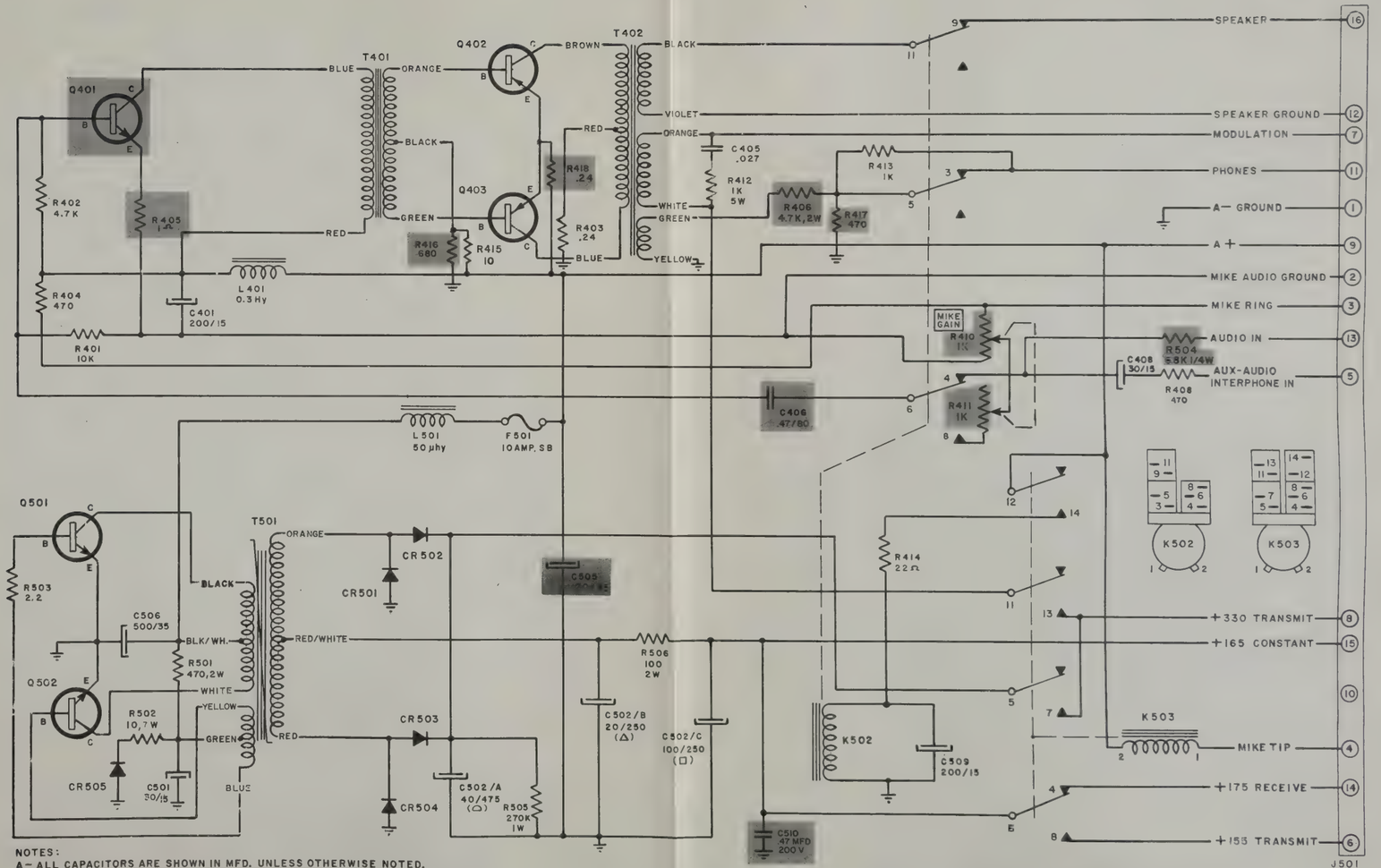
To increase headphone and speaker output, R406 and R503 were changed, R417 was added.

CNPB144-C7

To prevent distortion in cold temperatures R416 was changed. R415 was Relocated.
To increase modulation gain, R405 and R418 were added.

Changed	R416	31141-681	RESISTOR, CARBON, 680 ±10%, ½W
Changed	R405	31141-109	RESISTOR, CARBON, 1 ohm ±10%, ½W
Added	R418	31187-1	RESISTOR, Temp. Sensitive, 0.24 ohm 10% + t. c.
Added	R504	31192-682	RESISTOR, CARBON, 6.8K ±10%, ¼W

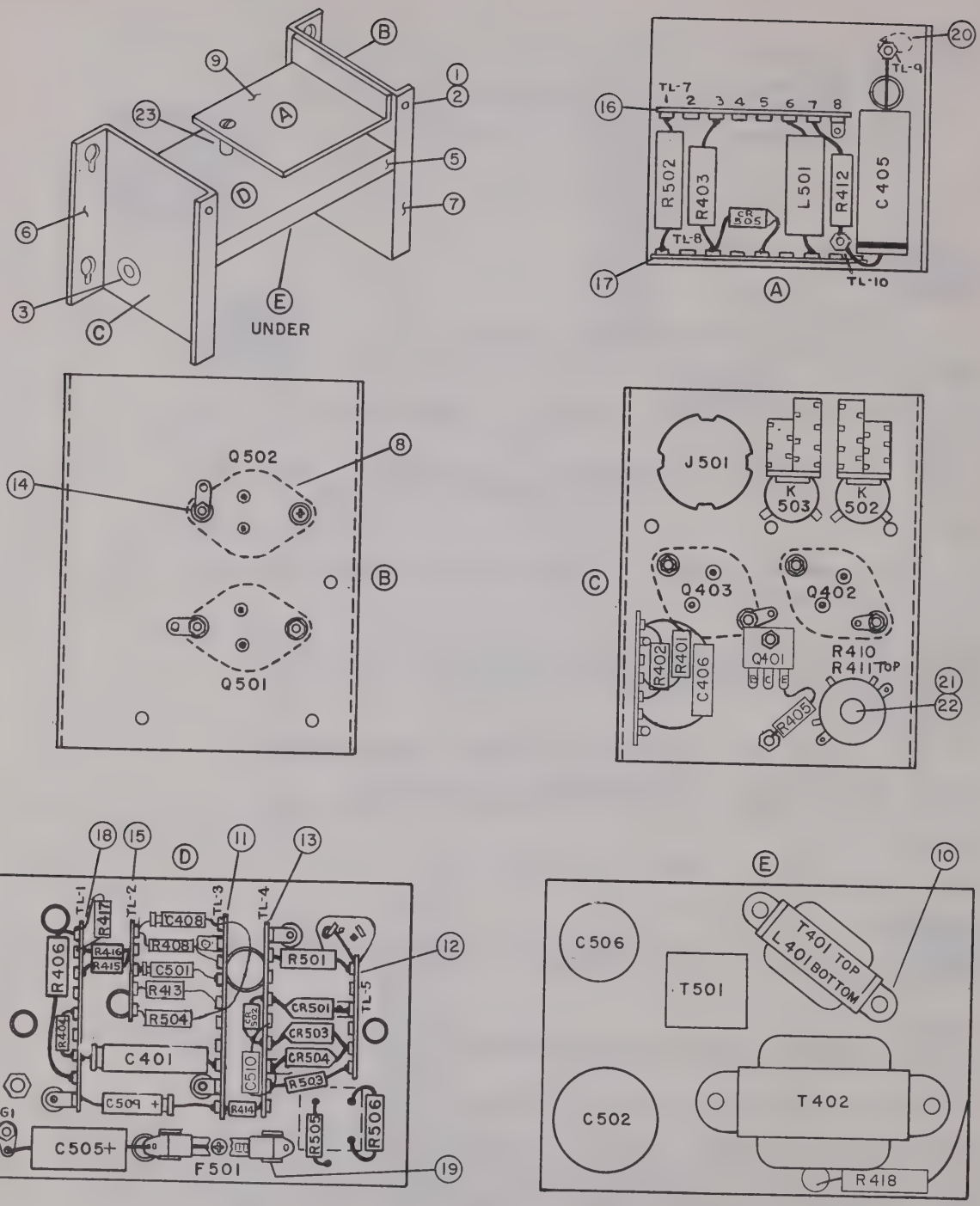
SEE DRAWING, OTHER SIDE



NOTES:
A— ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B— ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K = 1000 MEG = 1,000,000
C—RELAYS SHOWN IN RECEIVE POSITION.

T-02240-U

Figure 6-15 Modulator - Power Unit, T12 MP-12AH-1 (for chassis CNPB144-C2 thru C7)



T(12) MP12AH-1

T-02240-U

CHASSIS CNPB144-C7

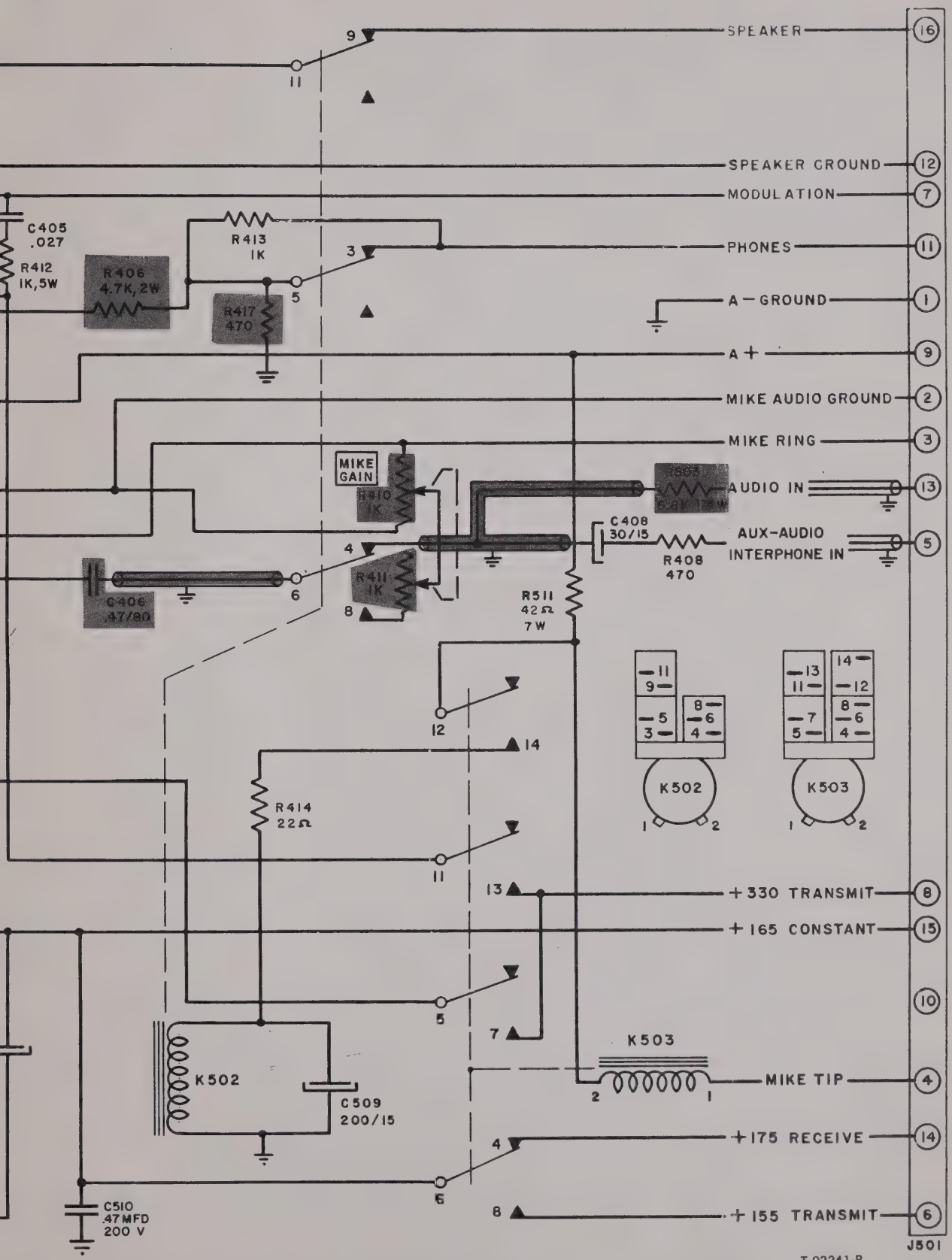
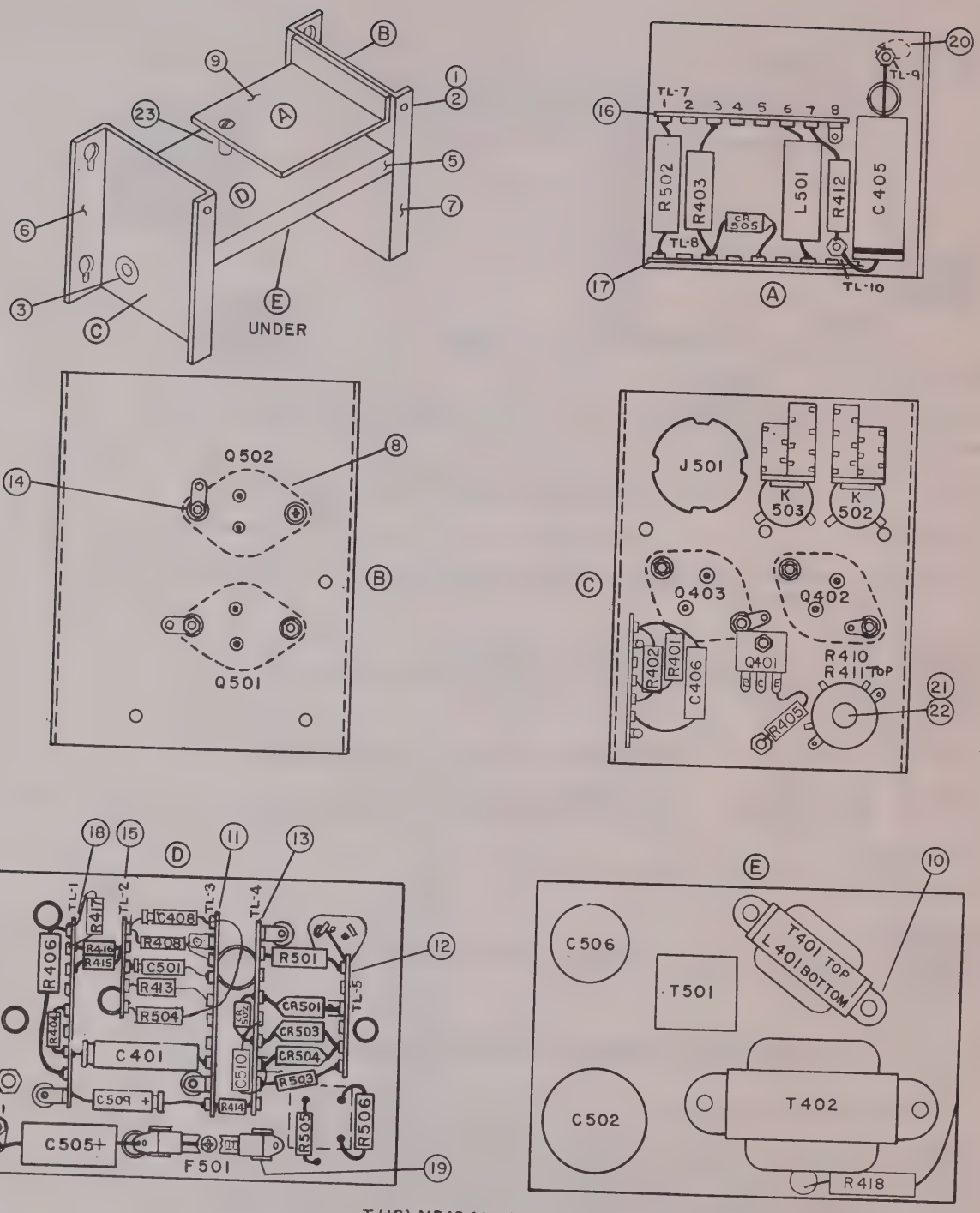


Figure 6-16 Modulator-Power Unit, T24 MP-12AH-1
(for chassis CNPB144-C2 thru C6)



T (12) MP12AH-1

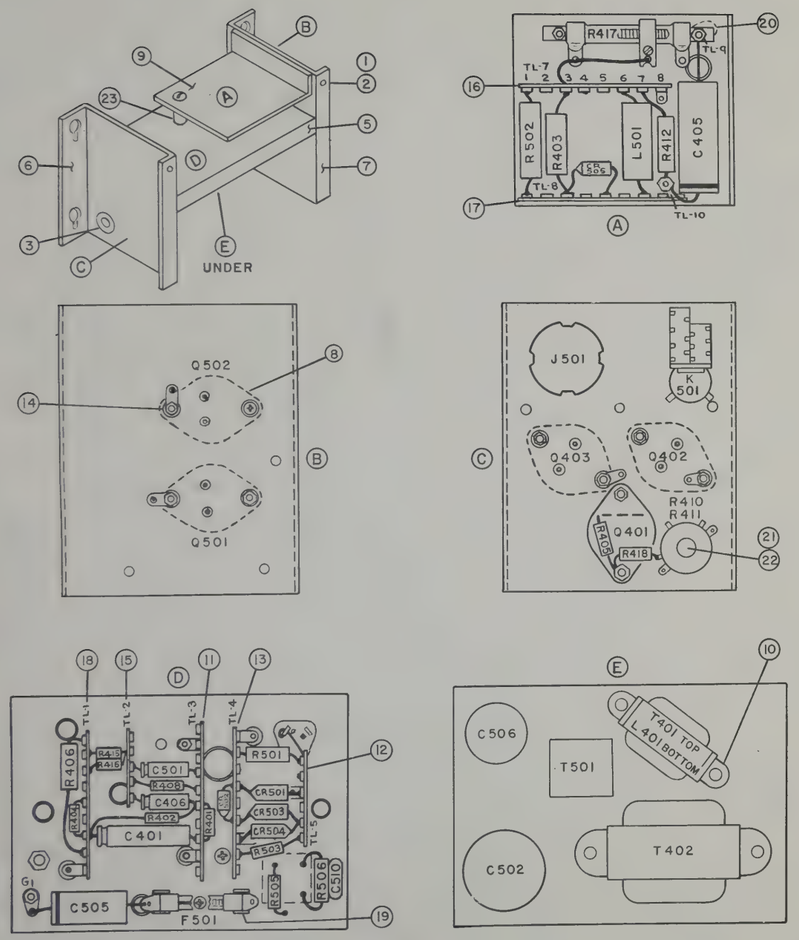
T-02240-U

CHASSIS CNPB144-C7

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place.

The Modulator-Power Unit identified as CNPB144C1 was modified by adding C510 and by changing the value of C505.

C505	21554-10	CAPACITOR, ELECTROLYTIC, 20 mfd, 35 v	CHANGED
C510	23094-183	CAPACITOR, MYLAR, .47 mfd, 200 v	ADDED



T(12)MP-12A-1 (CNPB144C1)

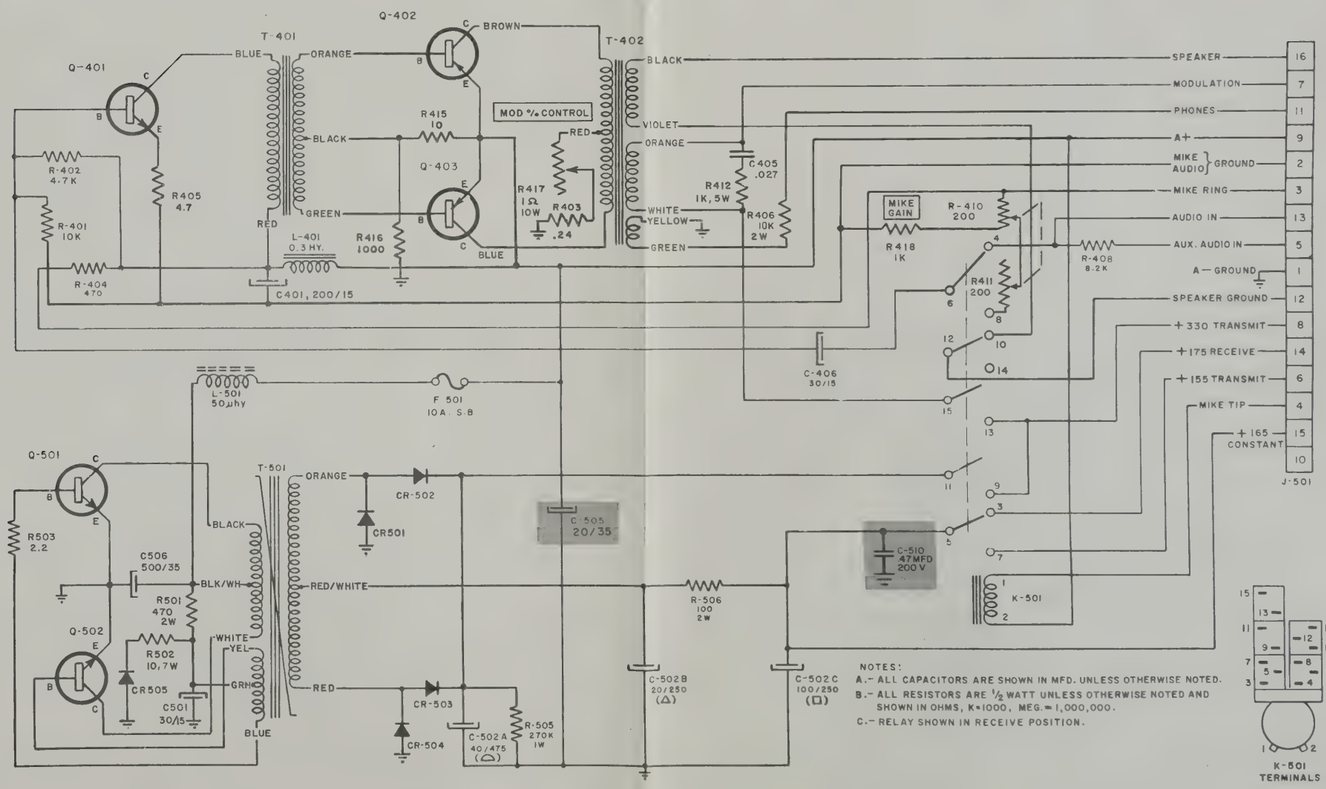
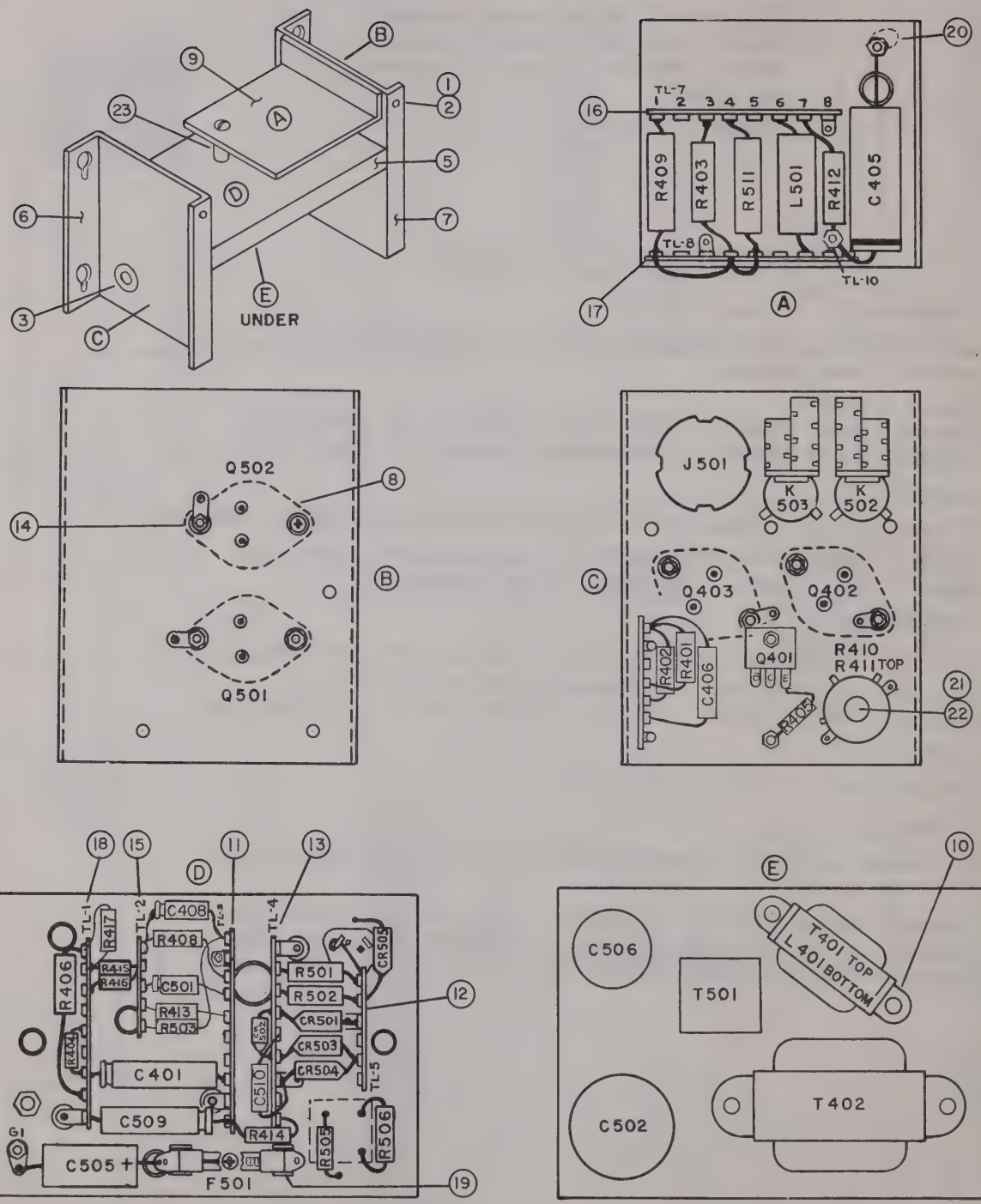


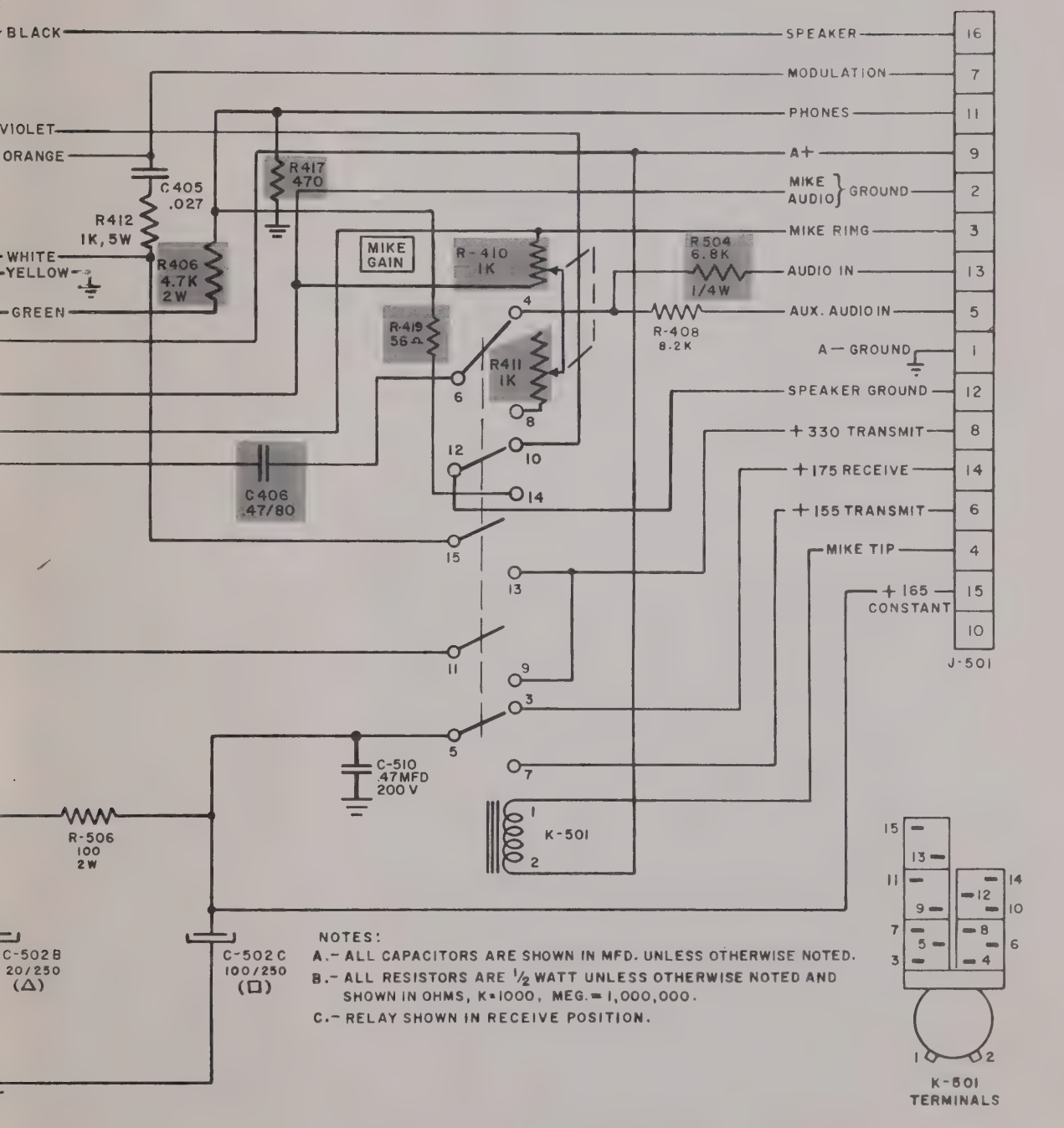
Figure 6-5 MODULATOR-POWER UNIT, T(12)MP-12A-1 (CNPB144C1) (Drawing and Schematic)



T(24) MP12 AH-1

T-02241-P

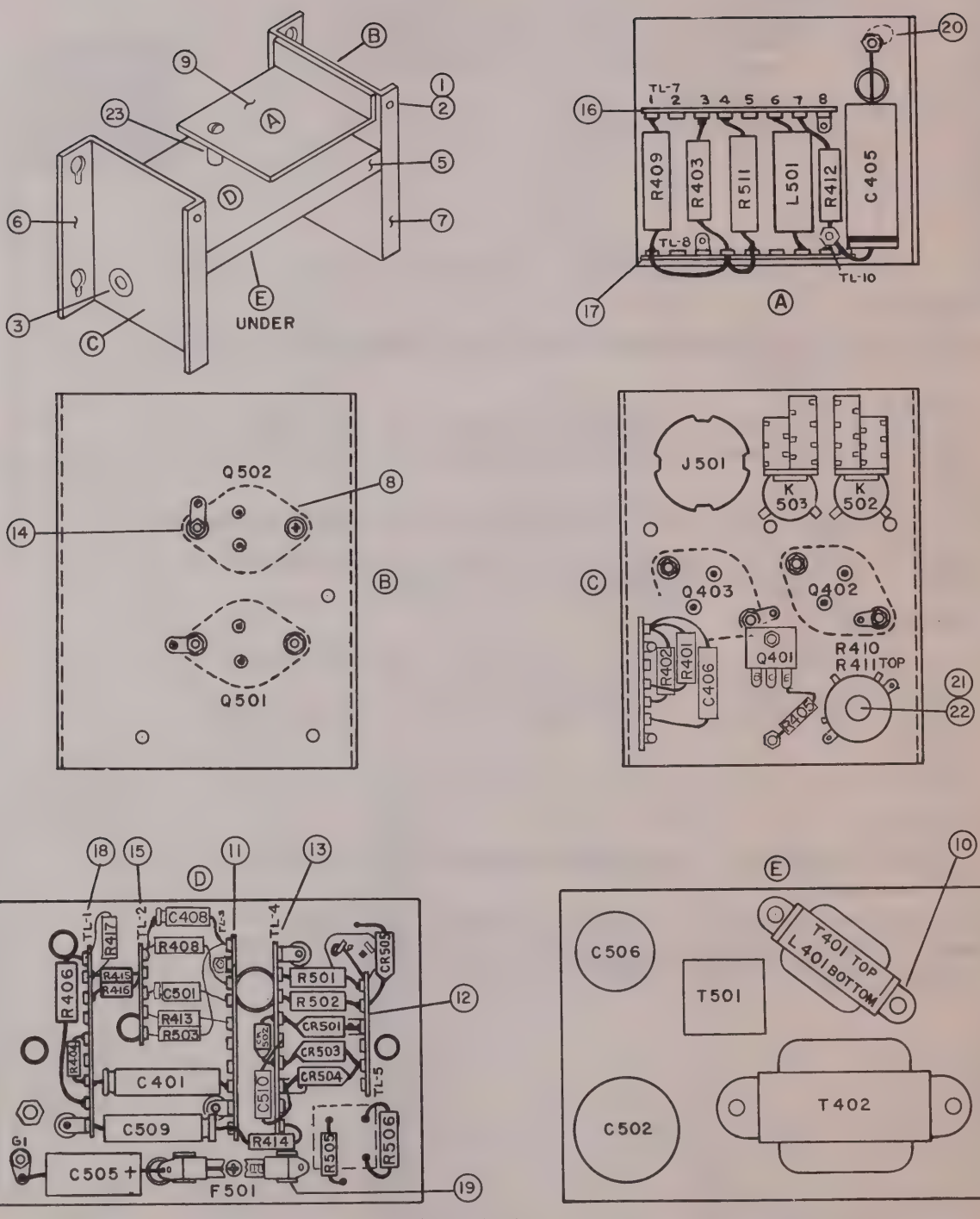
CHASSIS CNPB144-C6



NOTES:
A.- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B.- ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K=1000, MEG.=1,000,000.
C.- RELAY SHOWN IN RECEIVE POSITION.

T-02242-U

Figure 6-17 Modulator-Power Unit, T12 MP-12A-1 (for chassis CNPB144-C3 thru C9)



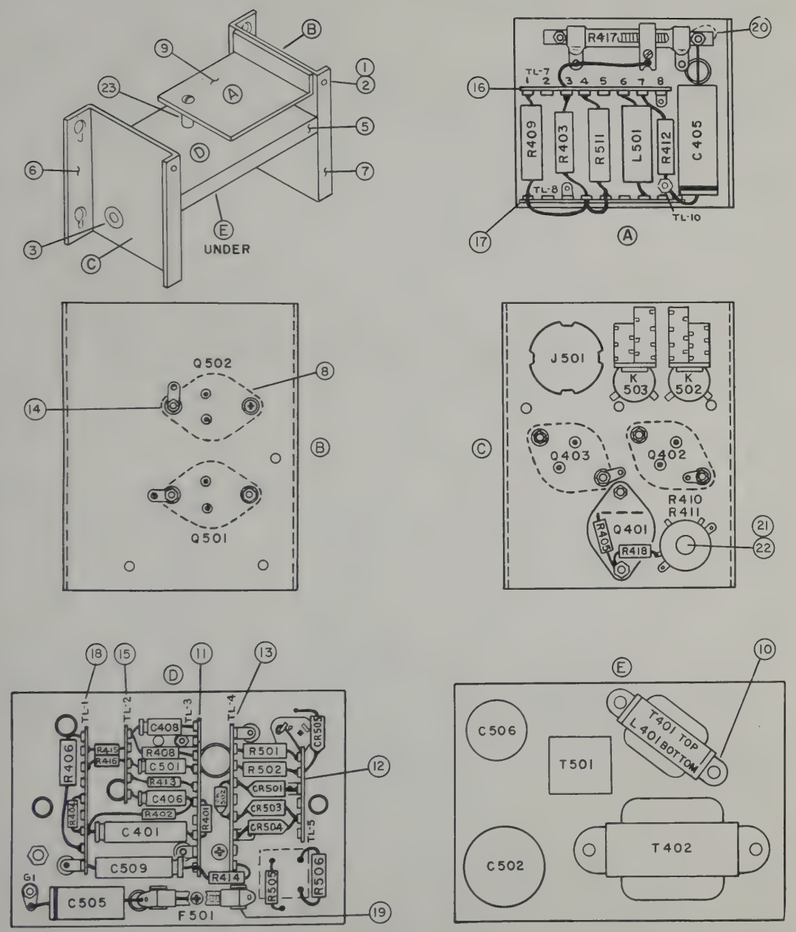
T(24) MP12 AH-1

T-02241-P

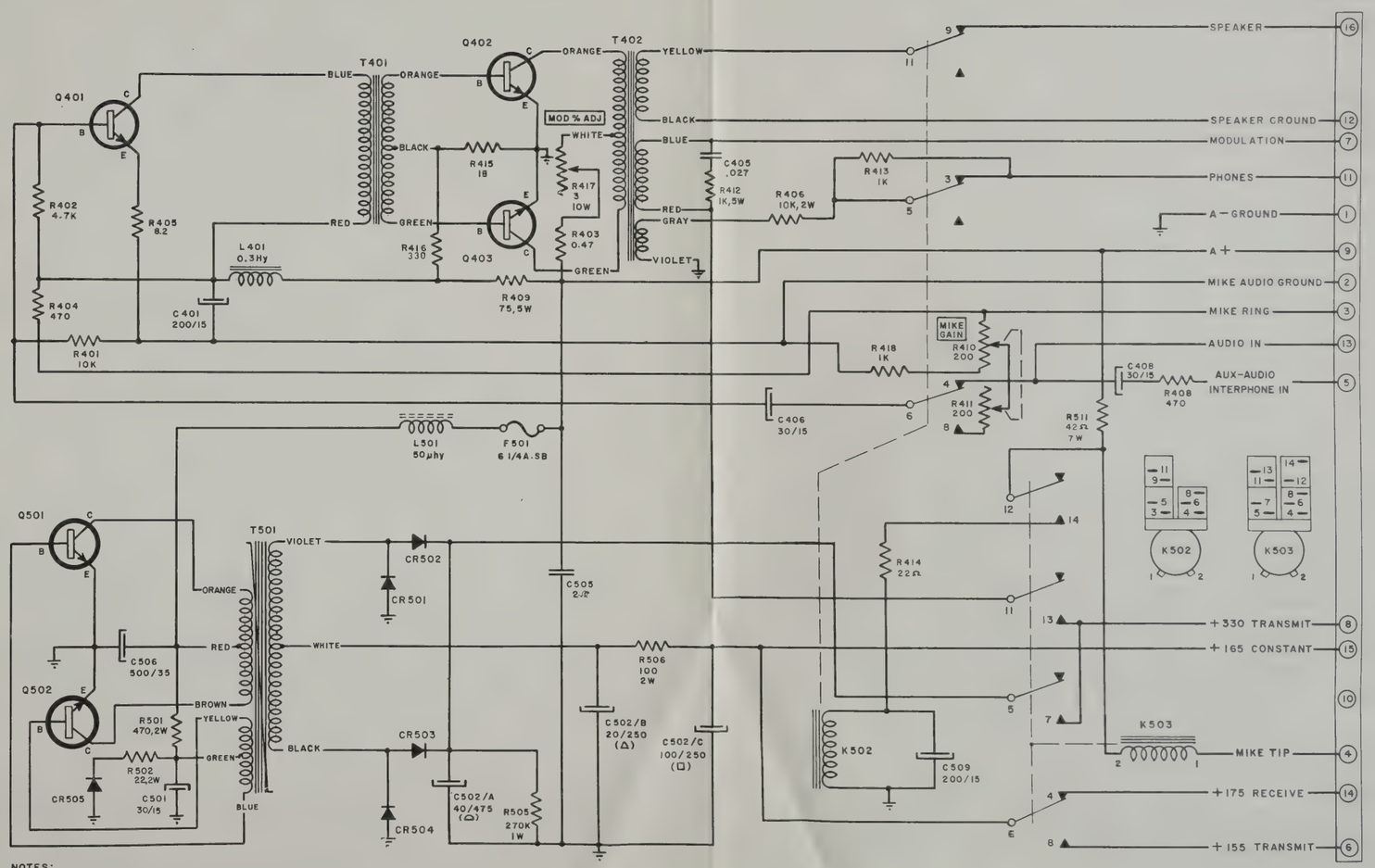
CHASSIS CNPB144-C6

TEST POINTS

See Fig. 6-2 for test points and values.

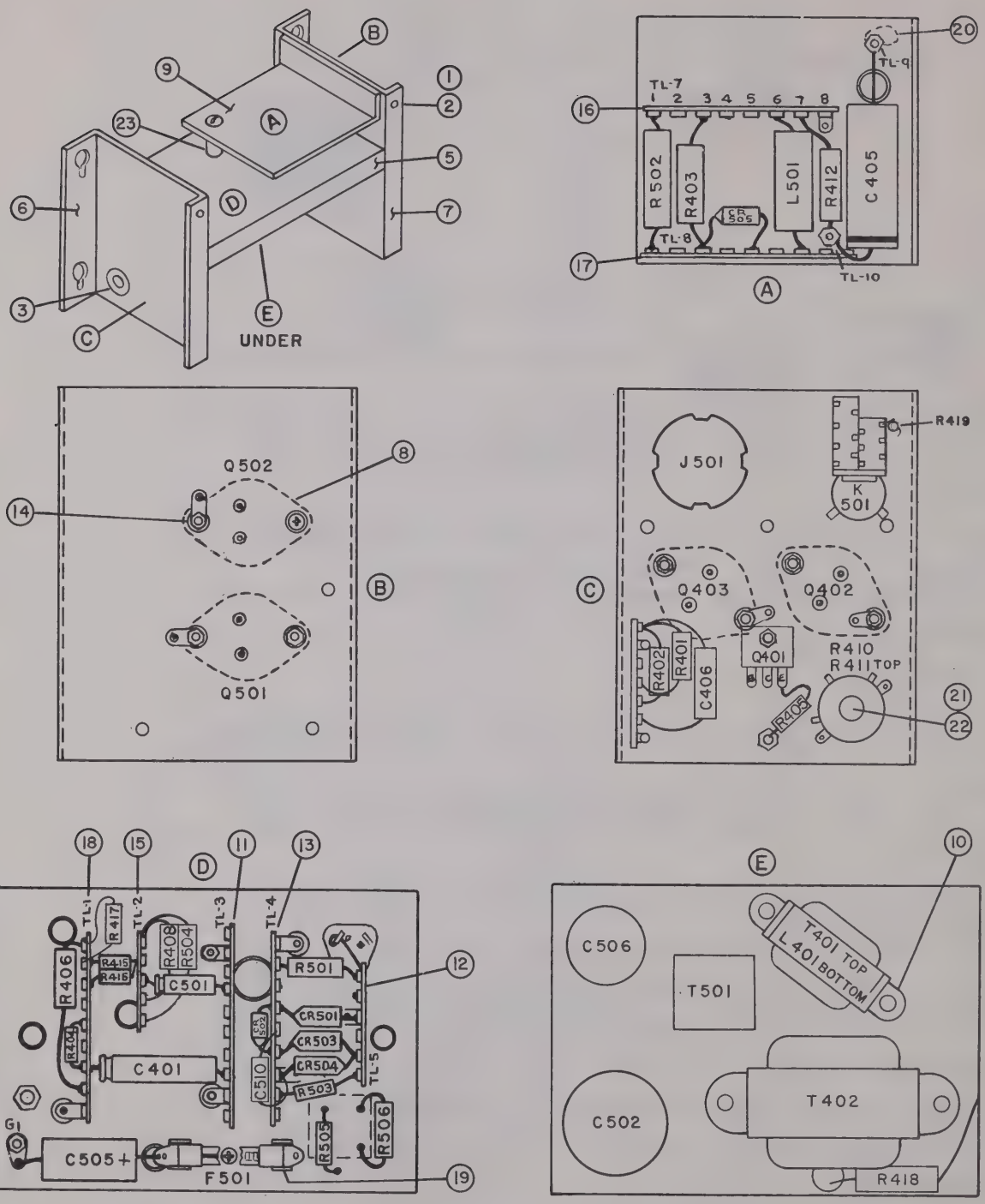


T(24) MP-12AH-1
Parts Location Drawing



NOTES:
A- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B- ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K = 1000, MEG = 1,000,000.
C- RELAYS SHOWN IN RECEIVE POSITION.

Figure 6-4 MODULATOR-POWER UNIT, (T24) MP-12AH-1
(Drawing and Schematic)



TP(12) 12 MP A-1

T-02242-U

CHASSIS CNPB144-C9

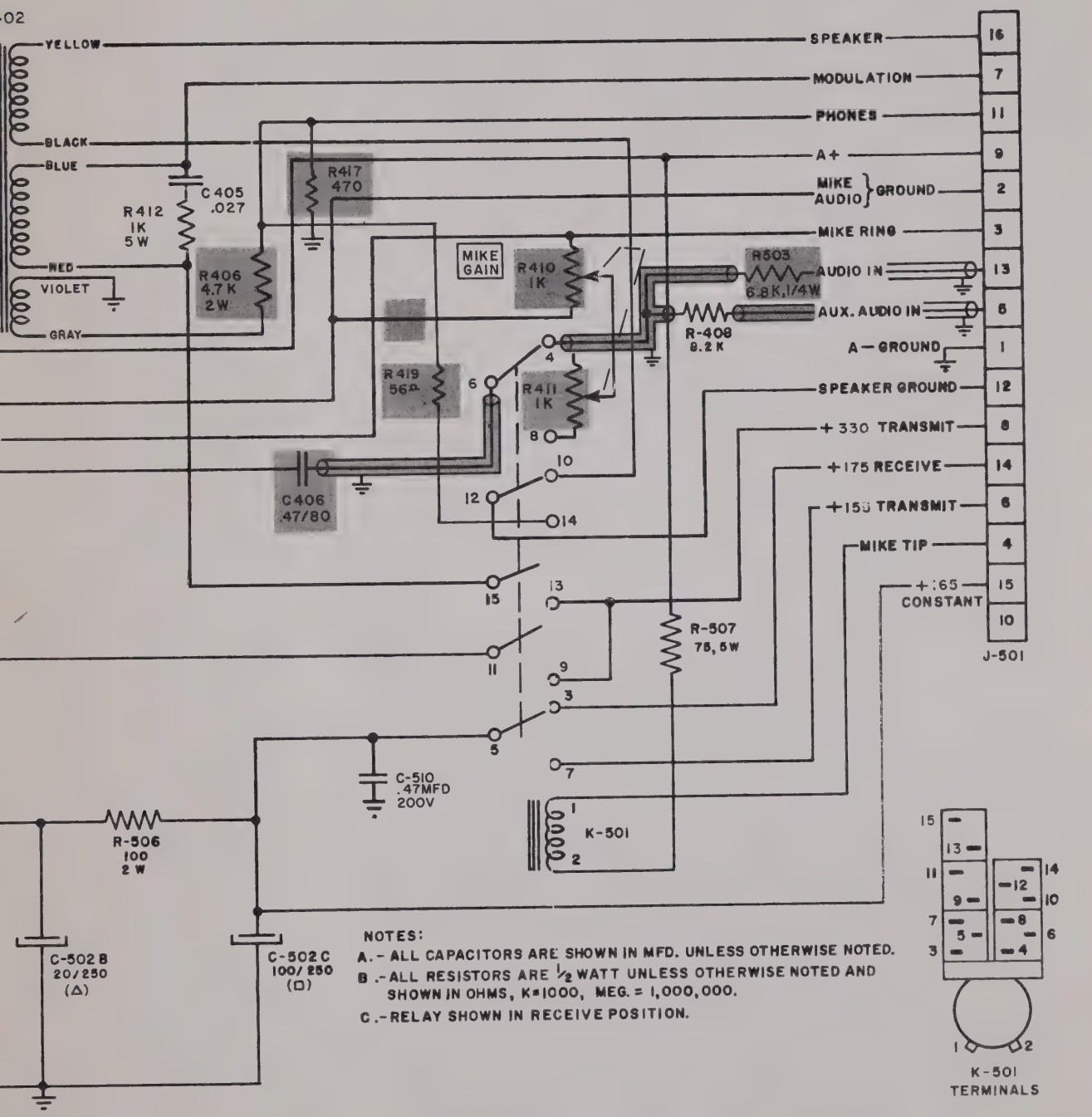
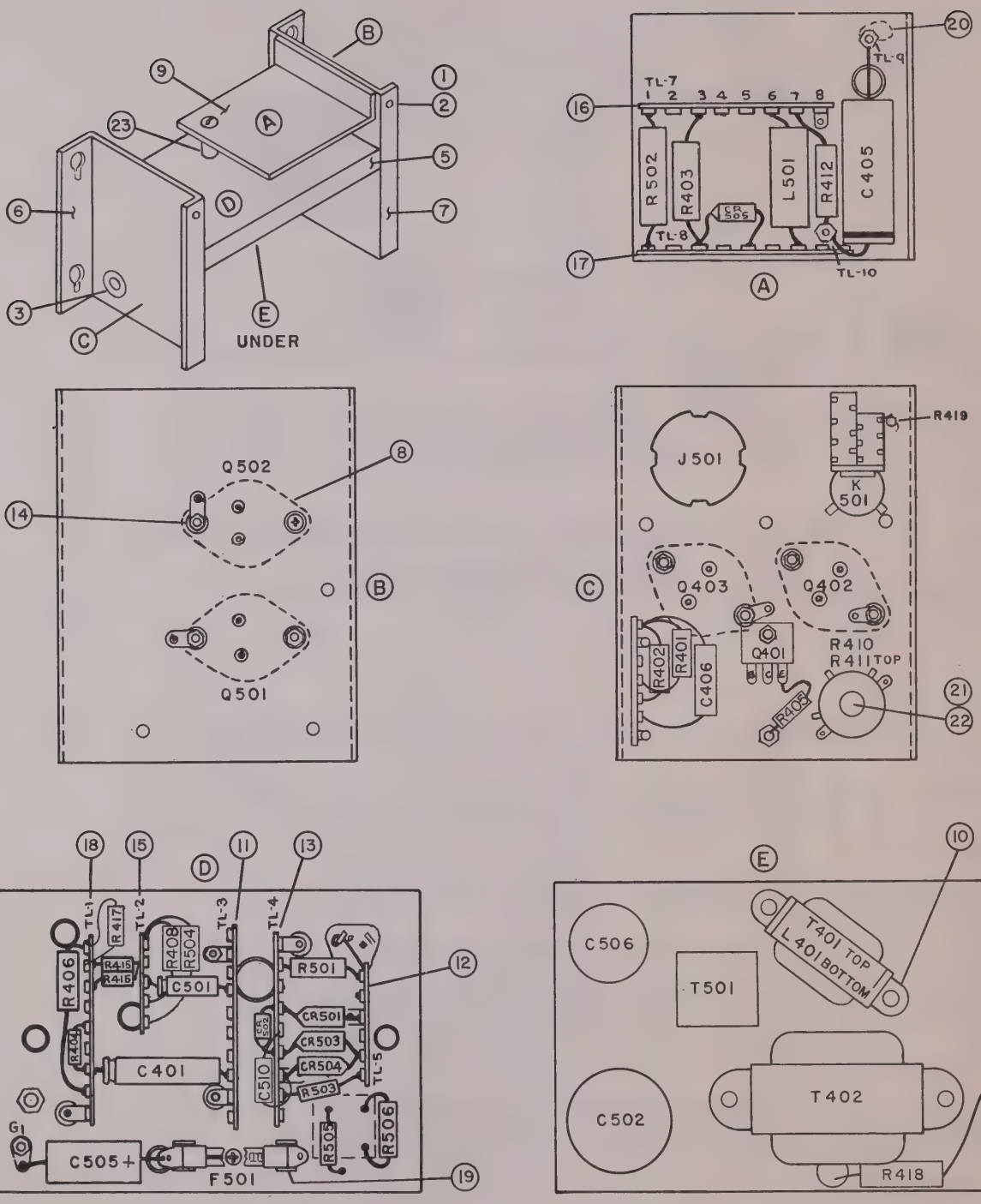


Figure 6-18 Modulator-Power Unit, T24 MP-12A-1 (for chassis CNPB144-C2 thru C7)



TP(12) 12 MP A-1

T-02242-U

CHASSIS CNPB144-C9

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

T24 MP-12AH-1 / T-02241-P

CNPB144-C2

To provide for increased mike gain adjustment range, R418 was removed, R410 and R411 were changed.

Deleted	R418		
Changed	R410	32045-5	RESISTOR, CARBON, 1K ±10%, ½W
Changed	R411	32045-5	RESISTOR, CARBON, 1K ±10%, ½W

CNPB144-C3

To reduce alternator whine R503 was added as well as the coaxial line shown.

Added	R503	31192-153	RESISTOR, CARBON, 15K ±10%, ¼W
Added		90071	CABLE, Coaxial, RG-196/U

CNPB144-C4

Q401 was changed and to improve audio response, C406 was changed.

Changed	Q401	75576-2	Transistor, SILICON, NPN
Changed	C406	23089-83	CAPACITOR, MYLAR, .47mfd ±10%, 80v

CNPB144-C5

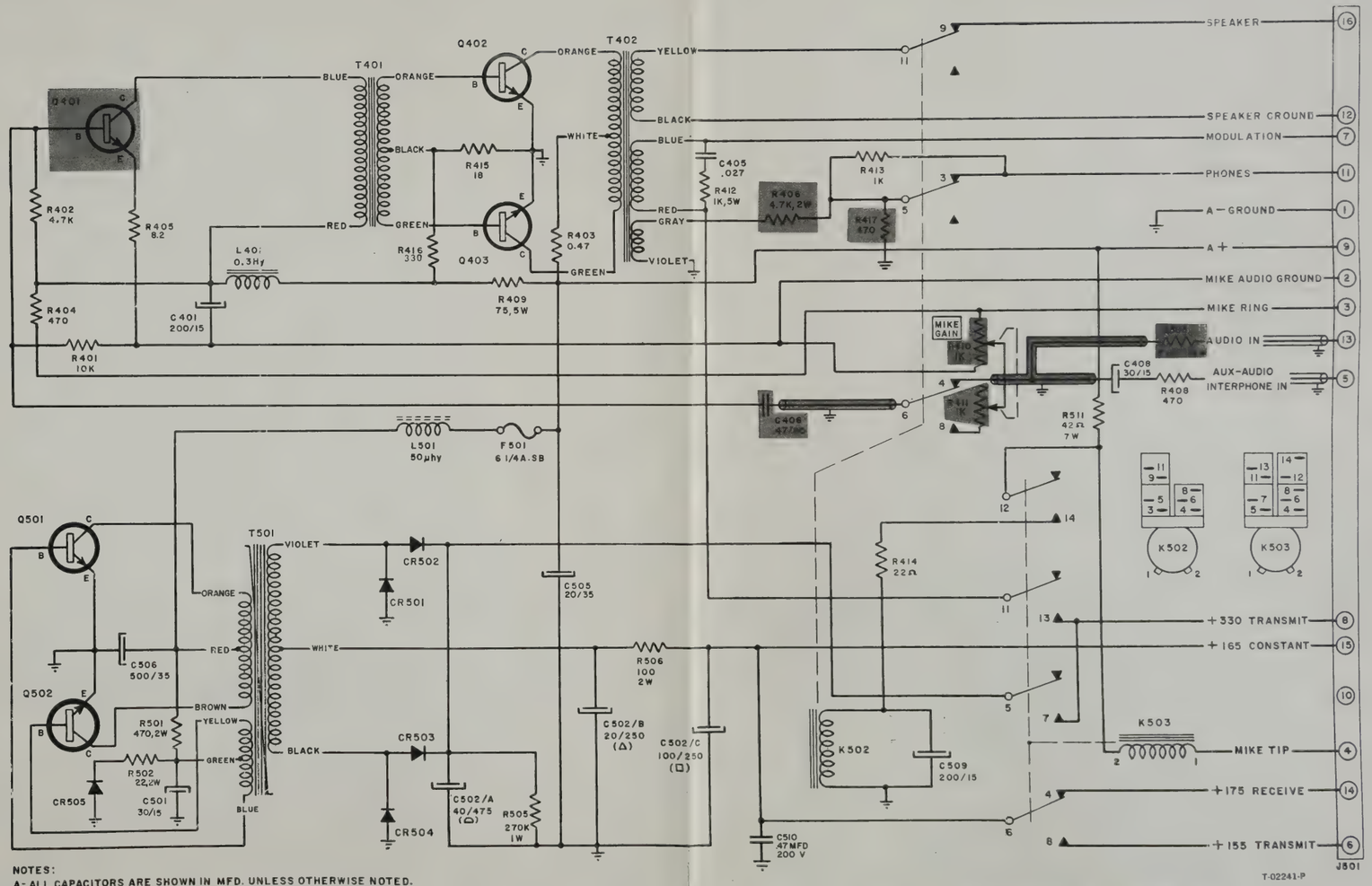
Deleted	R417		

CNPB144-C6

To increase headphone and speaker output, R406 and R503 were changed, R417 was added.

Changed	R406	31136-472	RESISTOR, CARBON, 4.7K ±10%, 2W
Added	R417	31141-471	RESISTOR, CARBON, 470 ±10%, ½W
Changed	R503	31192-682	RESISTOR, CARBON, 6.8K ±10%, ¼W

SEE DRAWING, OTHER SIDE



NOTES:
A- ALL CAPACITORS ARE SHOWN IN MFD. UNLESS OTHERWISE NOTED.
B- ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED AND SHOWN IN OHMS, K = 1000, MEG = 1,000,000.
C- RELAYS SHOWN IN RECEIVE POSITION.

Figure 6-16 Modulator-Power Unit, T24 MP-12AH-1 (for chassis CNPB144-C2 thru C6)

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

T12 MP-12A-1 /T-02242-U

CNPB144-C3

To provide for increased mike gain adjustment range, R418 was removed, R410 and R411 were changed.

Deleted	R418		
Changed	R410	32045-5	RESISTOR, CARBON, 1K ±10%, ½W
Changed	R411	32045-5	RESISTOR, CARBON, 1K ±10%, ½W

CNPB144-C4

Q401 was changed and to improve audio response, C406 was changed.

Changed	Q401	75576-2	TRANSISTOR, SILICON, NPN
Changed	C406	23089-83	CAPACITOR, MYLAR, .47mfd ±10%, 80v

CNPB144-C5

Deleted R417

CNPB144-C6

To increase headphone and speaker output, R406 was changed and R417 was added.

Changed	R406	31136-472	RESISTOR, CARBON, 4.7K ±10%, 2W
Added	R417	31141-471	RESISTOR, CARBON, 470 ±10%, ½W

CNPB144-C7

To prevent distortion in cold temperatures R416 was changed.
R415 was Relocated.
To increase modulation gain, R405 and R418 were added.

Changed	R416	31141-681	RESISTOR, CARBON, 680 ±10%, ½W
Changed	R405	31141-109	RESISTOR, CARBON, 1 ohm ±10%, ½W
Added	R418	31187-1	RESISTOR, Temp. Sensitive, 0.24 ohm 10% + t. c.

CNPB144-C8

To reduce side tone voltage into headphones, R419 was added.

Added	R419	31141-56	RESISTOR, CARBON, 56 ±10%, ½W

CNPB144-C9

Added	R504	31192-682	RESISTOR, CARBON, 6.8K ±10%, ¼W

SEE DRAWING, OTHER SIDE

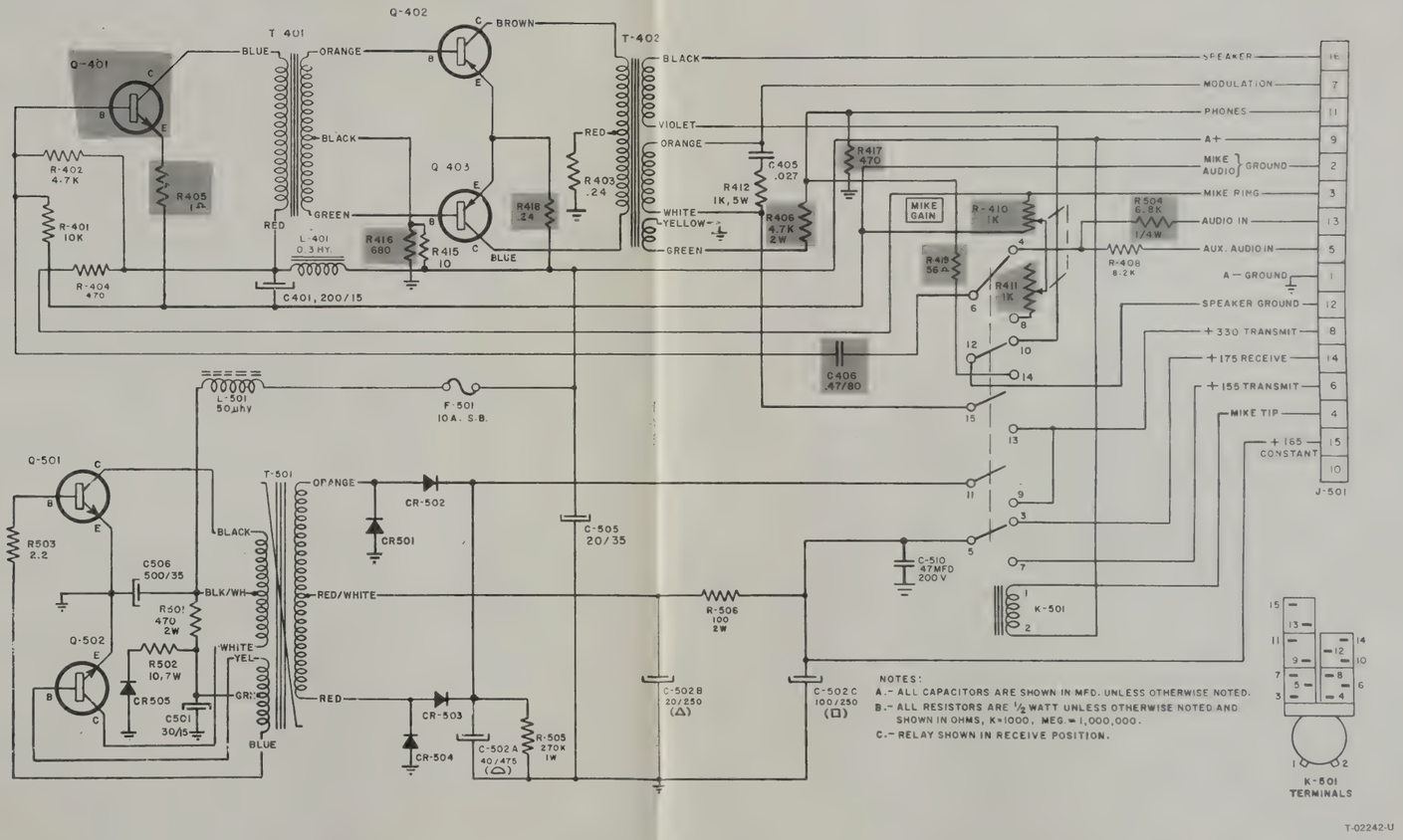


Figure 6-17 Modulator-Power Unit, T12 MP-12A-1 (for chassis CNPB144-C3 thru C9)

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

T24 MP-12A-1 / T-02243-P

CNPB144-C2

To provide for increased mike gain adjustment range, R418 was removed, R410 and R411 were changed.

Deleted	R418		
Changed	R410	32045-5	RESISTOR, CARBON, 1K ±10%, ½W
Changed	R411	32045-5	RESISTOR, CARBON, 1K ±10%, ½W

CNPB144-C3

To reduce alternator whine R503 was added as well as the coaxial line shown.

Added	R503	31192-153	RESISTOR, CARBON, 15K ±10%, ¼W
Added		90071	CABLE, Coaxial, RG-196/U

CNPB144-C4

Q401 was changed and to improve audio response, C406 was changed.

Changed	Q401	75576-2	TRANSISTOR, SILICON, NPN
Changed	C406	23089-83	CAPACITOR, MYLAR, .47mfd ±10%, 80v

CNPB144-C5

Deleted R417

CNPB144-C6

To increase headphone and speaker output, R406 and R503 were changed, R417 was added.

Changed	R406	31136-472	RESISTOR, CARBON, 4.7K ±10%, 2W
Added	R417	31141-471	RESISTOR, CARBON, 470 ±10%, ½W
Changed	R503	31192-682	RESISTOR, CARBON, 6.8K ±10%, ¼W

CNPB144-C7

To reduce side tone voltage into headphones, R419 was added.

Added	R419	31141-56	RESISTOR, CARBON, 56 ±10%, ½W

SEE DRAWING, OTHER SIDE

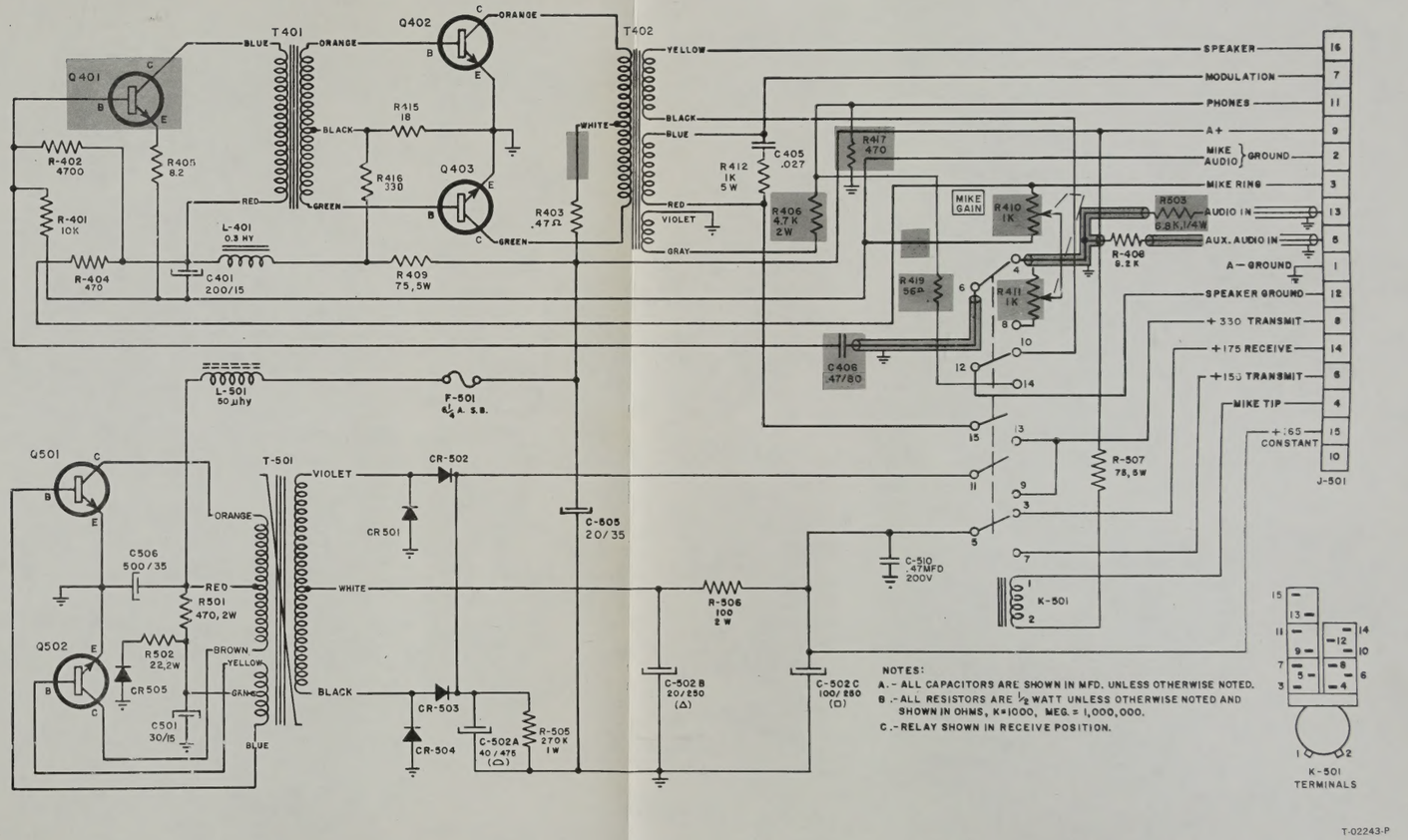
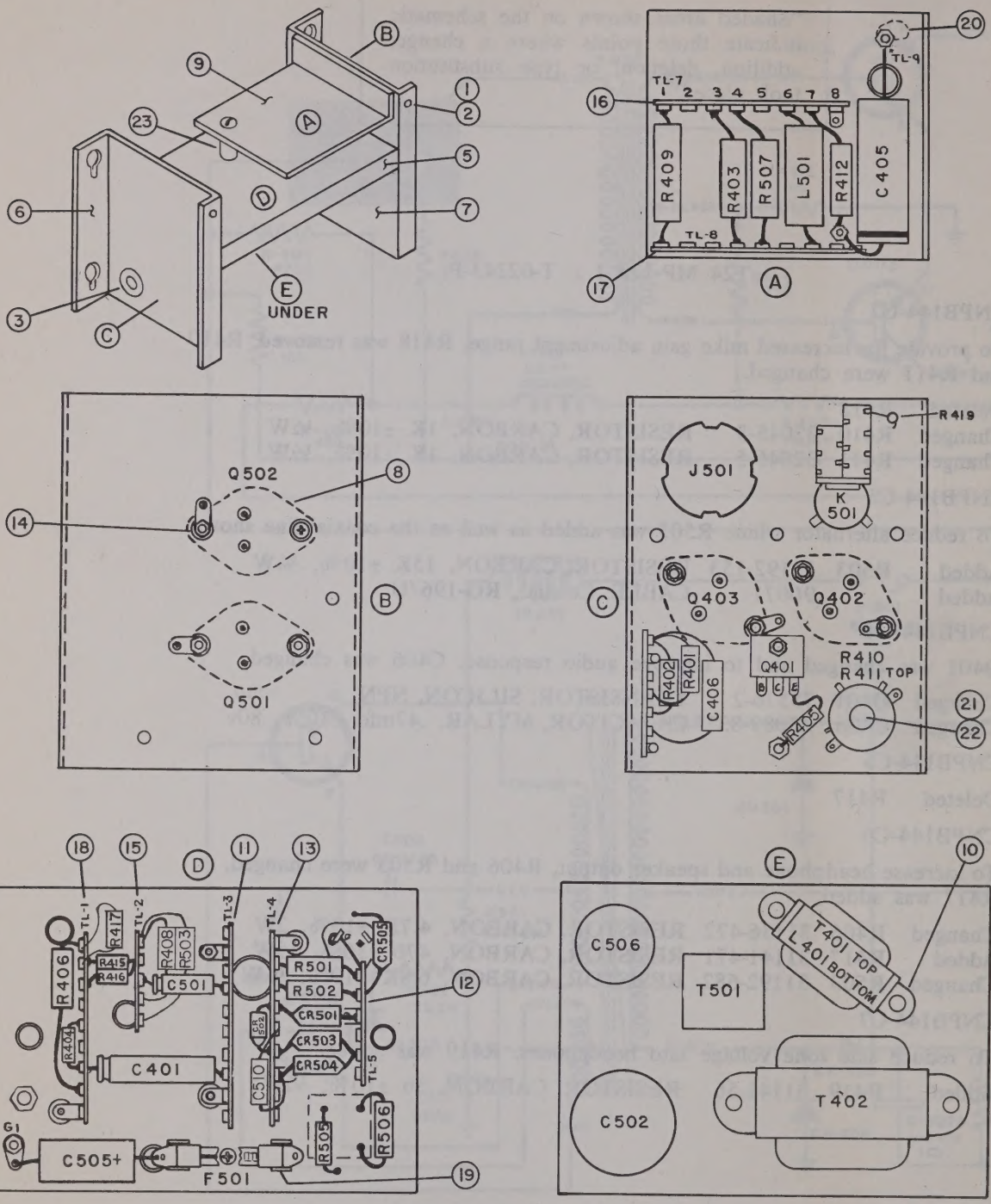


Figure 6-18 Modulator-Power Unit, T24 MP-12A-1 (for chassis CNPB144-C2 thru C7)



T(24) MP 12 A-1

T-02243-P

CHASSIS CNPB144-C7

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